BLM LIBRARY
88064980

OIL SHALE TRACT C-b

ENVIRONMENTAL AND EXPLORATION PROGRAM

SUMMARY REPORT #6

(Through February 29, 1976)

C-b SHALE OIL PROJECT

Ashland Oil, Inc.
Shell Oil Company, Operator

TN
859
.C64
C3747
no.6
c.2

ID88064980

BLM Library
D-553A, Building 50
Denver Federal Center
P. O. Box 25047
Denver, CO 80225-0047

TN
859
.C64
C3747
no. 6
c. 3

U. S. DEPARTMENT OF THE INTERIOR

PROTOTYPE OIL SHALE LEASING PROGRAM

TRACT C-b

SUMMARY REPORT #6

(Through February 29, 1976)

Submitted to:

Mr. Peter A. Rutledge
Area Oil Shale Supervisor
Conservation Division
U. S. Geological Survey
Grand Junction, Colorado

By:

C-b Shale Oil Project

Ashland Oil, Inc.
Shell Oil Company, Operator

1700 Broadway
Denver, Colorado 80202

May 5, 1976

TRACT C-b
SUMMARY REPORT #6
(Through February 29, 1976)

TABLE OF CONTENTS

Page

INTRODUCTION 1

I. PRE-EXPLORATION ENVIRONMENTAL RECONNAISSANCE SURVEYS 2

II. ENVIRONMENTAL BASELINE MONITORING PROGRAMS 3

A. Hydrology and Water Quality 3
1. Surface Water 3
2. Springs and Seeps 10
3. Ground Water 10

B. Air Quality 16
1. Air Quality and Surface Meteorology 16
2. Low Altitude Meteorology 59
3. Upper Air Studies 59
4. Visibility 68
5. Noise 78
6. Atmospheric Diffusion Studies 78

C. Biology 83
1. Terrestrial Wildlife Studies 83
2. Aquatic Studies 95
3. Terrestrial Vegetation Studies 102
4. Soil Survey and Productivity Assessment Studies . . 108

D. Geology 115

E. Ecological Interrelationships 116
1. Introduction 116
2. Discussion of System Variables and Processes . . . 116
3. Geology - Soil-Plant Interrelationships 122
4. Bibliography 130

III. OTHER STUDIES 131

A. Fish and Wildlife Management Plan 131
B. Revegetation Program 132
C. Microenvironmental Program 133
D. Aerial Photographic Program 131
E. Archaeological Studies 131
F. Scenic Values Program 131

TRACT C-b
SUMMARY REPORT #6
(Through February 29, 1976)

LIST OF FIGURES

Figure Number	Title	Page
II B-1	Air Quality and Meteorological Station Locations	17
II B-2	Air Parcel Trajectories	36
II B-3	Station 023, 30' Elevation Wind Roses ('75-'76)	57
II B-4	Station 021, 30' Elevation Wind Roses ('75-'76)	58
II B-5	Quarterly Wind Rose - 100' Level, Sept, '75 - Nov. '75	60
II B-6	Probability of Inversion as Function of Hour of Day	69
II B-7	Altitude Versus Hour of Day	70
II B-8	Summary by Season of Mean Altitude	71
II B-9	Calculated Probability of Occurrence ($p \geq .5$)	72
II B-10	Probability of Inversion	73
II B-11	Piceance Creek Basin Visibility Study, Camera Site and Views	74
II B-12	Composite Visual Range Distribution Piceance Creek Basin, Colorado, Winter, 1975-76	79
II B-13	Variation in the Mean Hourly Visual Range Piceance Creek Basin, Colorado, Winter, 1975-76	80
II B-14	Critical Wind Speed for Max. Ground Concentration of Plume and Corresponding Plume Rise	82
II C-1	Avifauna Strip Transect Locations, Tract C-b Study Area	89
II C-2	Seasonal Variation in the Standing Dead and the Litter and Prostrate Dead Fractions of the Herb Layer	103
II C-3	Stem Age Frequency Distributions for Big Sagebrush (*Artemisia tridentata*) and Mountain Mahogany (*Cercocarpus montanus*)	105
II C-4	Stem Age Frequency Distributions for Serviceberry (*Amelanchier alnifolia*), Bitterbrush (*Purshia tridentata*) and Rabbitbrush (*Chrysothamnus nauseosus*)	106
II C-5	Stem Age Frequency Distributions for Big Sagebrush (*Artemisia tridentata*), Pinyon Pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*)	107
II C-6	Soil Sample Location Map	112
II E-1	A Simplified Diagram of Biomass and Human Population Subsystems in the C-b Tract Area	118
II E-2	Flows in the Subsystems of Figure II E-1 and the Factors Influencing Each Flow	120
II E-3	A Diagram of Biomass and Human Population Subsystems Showing Factors Influencing Each Flow and Showing Oil Shale Development As a Driving Variable Affecting Both Subsystems	121
II E-4	Surface Geology C-b Tract	125

LIST OF FIGURES

(Continued)

Figure Number	Title	Page
II E-5	Vegetation Map Tract C-b	127
II E-6	Soils Map Tract C-b	128

TRACT C-b
SUMMARY REPORT #6
(Through February 29, 1976)

LIST OF TABLES

Table Number	Title	Page
II A-1	Surface Water Quality Baseline Data, U.S.G.S. No. 09306007	4
II A-2	Surface Water Quality Baseline Data, U.S.G.S. No. 09306022	5
II A-3	Surface Water Quality Baseline Data, U.S.G.S. No. 09306025	6
II A-4	Surface Water Quality Baseline Data, U.S.G.S. No. 09306058	7
II A-5	Surface Water Quality Baseline Data, U.S.G.S. No. 09306061	8
II A-6	Springs sampled	11
II A-7	Alluvial Wells sampled	11
II A-8	Deep Well Strings sampled	12
II A-9	Analytical Schedules #1 through 6	13
II A-10	1976 Ground Water Sampling Program	15
II B-1	Quarterly Summary (September 1975 - November 1975) Trailer No. 20	18
II B-2	Quarterly Summary (September 1975 - November 1975) Trailer No. 21	19
II B-3	Quarterly Summary (September 1975 - November 1975) Trailer No. 22	20
II B-4	Quarterly Summary (September 1975 - November 1975) Trailer No. 23	21
II B-5	Quarterly Summary (September 1975 - November 1975) Trailer No. 24	22
II B-6	Particulate Concentration Frequency Distribution, C-b Shale Oil Monitoring Project (September 1975 - November 1975)	23
II B-7	1-Hour Maximum Concentrations (SO_2 Constituent)	24
II B-8	1-Hour Maximum Concentrations (H_2S Constituent)	25
II B-9	24-Hour Maximum Concentrations (Particulate Constituent)	26
II B-10	3-Hour Maximum Concentrations (Methane HC Constituent)	27
II B-11	3-Hour Maximum Concentrations (Non-Methane HC Constituent)	28
II B-12	1-Hour Maximum Concentrations (CO Constituent)	29
II B-13	1-Hour Maximum Concentrations (NO Constituent)	30
II B-14	1-Hour Maximum Concentrations (NO_2 Constituent)	31
II B-15	1-Hour Maximum Concentrations (O_3 Constituent)	32
II B-16	Monthly Average Ambient Air Constituent Concentrations of Gases and Particulates	33

LIST OF TABLES

(Continued)

Table Number	Title	Page
II B-17	Trace Element Analyses of Composite Filter Samples on Tract C-b	41
II B-18	Trace Element Analyses of Single Filter Samples on Tract C-b	42
II B-19	Gross Radioactivity (pci/m^3)	43
II B-20	Volatile Trace Metal Concentrations - ug/m^3 on Tract C-b, 1976	44
II B-21	Size Distribution of Airborne Particulate Matter in the Respirable Ranges	45
II B-22	1-Hour Maximum Concentrations, Corrections for June-Oct. Data (NO_2 Constituent)	47
II B-23	1-Hour Maximum Concentrations, Updated for Aug.-Oct. Data (CO Constituent)	48
II B-24	Monthly Average Ambient Air Constituent Concentrations of Gases and Particulates, Updated for CO, Aug-Oct. Data	49
II B-25	Meteorological Summary: Temperature and Relative Humidity, 1975-1976	50
II B-26	Meteorological Summary: Temperature* 1975	51
II B-27	Meteorological Summary: Temperature 1975-1976	52
II B-28	Meteorological Summary: Wind Speed and Direction, 1975-1976 (30 Foot Height)	53
II B-29	Meteorological Summary: Wind Speed and Direction*, 1975-1976	54
II B-30	Meteorological Summary: Wind Speed and Direction*, 1975	55
II B-31	Preliminary Correlation of Wind Speed and Direction January 1976 - Hourly-Average Values	56
II B-32	Meteorological Summary: Stability Class Frequencies (%) 1975-1976	61
II B-33	Average Hourly Stability Classes, 1975-1976	62
II B-34	Relative Merits of Aircraft vs. Acoustic Sounder for Obtaining Temperature-Inversion Data	64
II B-35	Means and Standard Deviations of Inversion Durations and Maximum, Minimum and Average Inversion Heights by Month as Obtained from Acoustic Sounders	65
II B-36	Statistical Analysis of Published Aircraft and Acoustic Sounder Inversion Data	66
II B-37	Statistical Analysis of Aircraft and Acoustic Sounder Temperature Inversion Data Based on Best Agreement from All Data	67
II B-38	Visual Range (Miles) Statistics for All Views Combined for Each Month of Monitoring Piceance Creek Basins, Colorado, 1975-1976	76
II B-39	Visual Range Summary (Miles) Piceance Creek Basins, Colorado	77

LIST OF TABLES

(Continued)

Table Number	Title	Page
II C-1	Mule Deer Road Counts Conducted December 1975 and January and February 1976	84
II C-2	Percent Frequency* of Tracks From Counts Conducted on January 25, 1976	85
II C-3	Satellite Grids Trapping Data for January and March 1976	87
II C-4	Sigma and Home Range* Values for Least Chipmunks and Deer Mice on a Chained Pinyon-Juniper Site and a Pinyon-Juniper Woodland	88
II C-5	Description of the Eight Strip Transects on Tract C-b	90
II C-6	Results of Strip Transect Censuses of Birds at 8 Transects During February 1976	91
II C-7	Results of Qualitative County Surveys at Tract C-b Conducted February 8-12, 1976	92
II C-8	Diurnal Raptors Noted on or Close to Tract C-b During the Winter, 1975-1976 Sampling Period	94
II C-9	Numerical Abundance of Species of Fish Captured During January 1976 From Piceance and Stewart Creeks	96
II C-10	Benthic Invertebrates Collected on Tract C-b During January 1976	97
II C-11	Periphyton Productivity Estimates for Piceance Basin Station, January 1976	99
II C-12	Light and Dark Bottle Dissolved Oxygen Determinations[1] for Upper and Lower Willow Lakes and Upper[2] and Lower Stewart Lakes, January 1976	101
II C-13	Percentage Distribution of Herb Standing Crop at Each Clipping Data for the 1975 Growing Season	104
II C-14	Agronomic Characteristics of Additional Soil Samples Taken on Tract C-b	109
II C-15	Chemical and Physical Analyses of Soil Samples Collected on Tract C-b	110
II C-16	Nutrient Analysis of Seven Soil Samples from Tract C-b	111
II C-17	Soils of C-b Tract - Selected Soil Characteristics	113
II E-1	Vegetation and Soil Associations with a Given Surficial Deposit	123
III C-1	Microenvironmental Stations, September Monthly Summary	134
III C-2	Microenvironmental Stations, October Monthly Summary	135
III C-3	Microenvironmental Stations, November Monthly Summary	136

INTRODUCTION

Summary Report #6 and Quarterly Data Report #6 cover the sixth quarter of exploration and environmental data for the Environmental Baseline Program of Tract C-b. These reports specifically cover the winter quarter of December 1975 through February 1976. Quarterly Data Report #6 consists of three volumes of a comprehensive compilation of data submitted to the Area Oil Shale Supervisor in Grand Junction on April 15, 1976. Parties interested in reviewing the comprehensive data may contact the Area Oil Shale Supervisor's Office. This Summary Report #6 is intended to provide the reader with a general overview of the information included in the Quarterly Data Report #6. For a complete summary of on-Tract activities to date, reports from all six quarters must be consulted.

Since the beginning of the Project, the Lessee has submitted to the Area Oil Shale Supervisor six quarterly data reports, five summary reports, and an Annual Summary and Trends Report. Beginning with this quarter the outline of the data and summary reports has been changed slightly to provide for a more concise presentation of the water information and to include a section on Ecological Interrelationships. It is expected that the section on Ecological Interrelationships will provide a vehicle for presenting analysis of the data during the second baseline year. The Annual Summary and Trends Report presented the first attempt at a comprehensive analysis and included a major section on Ecological Interrelationships. The final baseline report is expected to present the results of our two-year baseline analysis and to focus on the important ecological interrelationships that exist on Tract C-b.

For ready reference, the reader is reminded that both outline and section numbering in summary and quarterly data reports are identical. Further, the complete data for this quarter are presented in Quarterly Data Report #6 to which the reader is referred for details.

I

PRE-EXPLORATION ENVIRONMENTAL RECONNAISSANCE SURVEYS

No environmental reconnaissance surveys were conducted during this quarter. The results of previous surveys are contained in Quarterly Data Reports #1 and #2 and are summarized in Summary Reports #1 and #2.

II

ENVIRONMENTAL BASELINE MONITORING PROGRAMS

II A HYDROLOGY

With the beginning of the 1976 water year (October 1975), a revised schedule of water monitoring activities has been adopted and approved by the Area Oil Shale Supervisor's Office. Measurements will be continued as before except that surface water-quality samples will be taken at monthly rather than semi-monthly intervals. Groundwater sampling frequencies will be changed also. Some minor changes have been made in the parameters monitored. Three new analytical areas have been added: a determination of the water quality of precipitation, an organic fractionation procedure for selected samples of both surface and ground waters, and a characterization of sediments.

II A-1 Surface Water

The new surface-water schedule will be based on monthly samples from the four major stations and any other station showing flow at the time of sampling. Field measurements will be made of temperature, specific conductance, pH, dissolved oxygen, color, and odor. Monthly laboratory analyses will be made for total alkalinity, ammonia, B, Ca, F, Fe, Mg, K, SiO_2, Na, HCO_3, CO_2, Cl, dissolved solids, Kjeldahl nitrogen (reported as N), nitrate plus nitrite (reported as N), As, Mn, phosphate (reported as total PO_4 and dissolved PO_4), dissolved organic carbon, suspended organic carbon, and SO_4.

Quarterly analyses will be made for Al, Br, Ba, Cd, Cu, Cr, oil and grease, Pb, Li, Hg, Mo, Se, sulfide, Zn, Cyanide, Sr, fecal coliform, fecal streptococcus, total coliform, COD, BOD, and phenols. A complete scan of elements will also be performed quarterly.

Samples will be taken at the two stations on Piceance Creek (09306007 and 09306061) and analyzed for MBAS. (Methlyene blue active substances are primarily phosphate detergents.) One sampling will be during the height of spring runoff; a second sampling will occur during late-summer low flow.

Radioactivity of samples of surface water will be determined quarterly at the four major gauging stations and at other stations quarterly (provided that flow occurs) or on an opportunistic basis. If gross alpha activity is greater than four picocuries/liter, then the sample will be analyzed for radium 226 and for natural uranium. If gross beta activity is greater than 100 picocuries/liter, the sample will be analyzed for Sr^{90} and for Ce^{137}.

Table II A-1

SURFACE WATER QUALITY
BASELINE DATA

STATION: U. S. G. S. No. 09306007 Piceance Creek Below Rio Blanco Co.

	1974 - 1975				1976 Water Year									
	n	mean	min	max	10/8	10/31	11/17	12/16						
1. Ammonia (mg/1) (Nitrogen)	20	.04	.00	.13	.02	.02	.02	.13						
2. Arsenic (ug/1)	42	2	0	5	2	2	2	2						
3. Barium (ug/1)	41	<87	0	200	100	200	300*	100						
4. Bicarbonate (mg/1)	44	528	390	617	503	552	500	505						
5. Boron (ug/1)	41	218	110	330	230	200	210	150						
6. Cadmium (ug/1)	40	<1	0	<15	0	0	-	1						
7. Calcium (mg/1)	45	69	51	79	64	73	63	64						
8. Carbonate (mg/1)	33	1.3	0	32	0	0	0	0						
9. Chloride (mg/1)	45	15	9	24	15	16	13	13						
10. Chromium (ug/1)	19	<6	0	90	0	0	-	0						
11. Color (PCU)					13	10	8	1						
12. Copper (ug/1)	40	3	0	12	2	1	-	0						
13. Cyanide (mg/1)	20	.00	.00	.02	.0	.0	-	.0						
14. Fluoride (mg/1)	45	1.0	.2	1.3	.8	.8	1.0	1.1						
15. Iron (ug/1)	45	70	0	390	50	70	20	10						
16. Kjeldahl Nitrogen (mg/1)	20	.87	.25	4.0	-	-	.45	.29						
17. Lead (ug/1)	40	<3	0	<16	3	2	-	3						
18. Lithium (ug/1)	40	7	0	20	10	5	20	10						
19. Magnesium (mg/1)	45	47	34	57	47	45	43	44						
20. Manganese (ug/1)	44	105	10	230				60						
21. Mercury (ug/1)	40	<.1	.0	.8	.0	.0	-	.1						
22. Nitrate (mg/1) as NO_3	20	1.4	.22	3.7										
23. Nitrite (mg/1) as NO_2	20	.03	.00	.13										
24. Odor	25	0	0	0										
25. Oil & Grease (mg/1)	19	2.7	0	10	0	0	-	0						
26. Ortho-Phosphorus (mg/1) (total)	20	.04	.01	.11	.0*	.02	.01	.03						
27. Potassium (mg/1)	45	3.7	2.4	19	3.3	3.7	2.6	2.3*						
28. Selenium (ug/1)	42	1	0	2	1	-	-	1						
29. Silica (mg/1)	45	15	3.4	18	16	16	15	16						
30. Sodium (mg/1)	45	125	75	160	130	130	120	120						
31. Solids, Dissolved (mg/1)	44	706	502	829	705	728	668	663						
32. Sulfate (mg/1)	45	160	110	200	180	170	160	150						
33. Sulfide (mg/1)	20	.2	.0	.9	.2	.0	-	.0						
34. Turbidity (JTU)	20	54.9	0	480										
35. Zinc (ug/1)	40	19	0	60	10	0	0	10						
36. pH	44	8.1	6.9	9.0	8.4	8.2	8.4	8.7						

*New Extreme

Table II A-2

SURFACE WATER QUALITY
BASELINE DATA

STATION: U. S. G. S. No. 09306022 Stewart Gulch Ab West Fork Nr Rio Blanco Co.

		1974 - 1975			1976 Water Year									
	n	mean	min	max	10/7	10/31	11/17	12/16						
1. Ammonia (mg/1) (Nitrogen)	20	.02	.00	.09	.03	.01	.0	.01						
2. Arsenic (ug/1)	33	1.0	0	4	1	1	1	1						
3. Barium (ug/1)	30	<75	0	<200	100	0		200*						
4. Bicarbonate (mg/1)	30	505	427	782	479	520	518	466						
5. Boron (ug/1)	30	103	30	530	90	200	80	90						
6. Cadmium (ug/1)	30	<1	0	3	0	0	-	1						
7. Calcium (mg/1)	30	93	73	99	95	91	98	97						
8. Carbonate (mg/1)	20	2	0	38	0	0	0	0						
9. Chloride (mg/1)	30	7.5	6	16	7.2	6.5	6.8	5.8*						
10. Chromium (ug/1)	20	<4	0	20	0	4	-	0						
11. Color (PCU)					5	2	2	1						
12. Copper (ug/1)	30	2.0	0	8	1	1	-	5						
13. Cyanide (mg/1)	20	.0	.00	.02	.0	.0	-	.0						
14. Fluoride (mg/1)	30	.4	.1	3.3	.2	.2	.3	.2						
15. Iron (ug/1)	30	87	0	1200	30	40	20	0						
16. Kjeldahl Nitrogen (mg/1)	20	.53	.14	3.5	-	-	.08	.02*						
17. Lead (ug/1)	30	3	0	7	2	0	-	2						
18. Lithium (ug/1)	30	8	0	40	10	5	-	0						
19. Magnesium (mg/1)	30	76	64	95	77	76	74	72						
20. Manganese (ug/1)	30	10	0	57	-	-	-	20						
21. Mercury (ug/1)	30	<.1	.0	.4	.0	.0	-	.2						
22. Nitrate (mg/1) as NO_3	20	6.7	.22	8.4										
23. Nitrite (mg/1) as NO_2	20	.02	.00	.13										
24. Odor	30	0	0	0										
25. Oil & Grease (mg/1)	20	3	0	9	0	0	-	0						
26. Ortho-Phosphorus (mg/1) (total)	20	.03	.01	.18	.0*	.02	.02	.02						
27. Potassium (mg/1)	30	1.7	1.1	2.5	1.3	1.5	1.3	1.4						
28. Selenium (ug/1)	30	1	0	2	1	2	-	1						
29. Silica (mg/1)	30	15	11	17	15	14	14	15						
30. Sodium (mg/1)	30	128	120	250	130	120	120	120						
31. Solids, Dissolved (mg/1)	30	951	865	1160	968	892	949	921						
32. Sulfate (mg/1)	30	370	330	490	400	320*	370	370						
33. Sulfide (mg/1)	20	.13	.0	.7	.5	.0	-	.0						
34. Turbidity (JTU)	20	11	0	30										
35. Zinc (ug/1)	30	31.0	0	370	10	0	0	0						
36. pH	30	8.2	7.2	8.8	7.9	8.0	8.2	8.6						

*New Extreme

Table II A-5

SURFACE WATER QUALITY
BASELINE DATA

STATION: U. S. G. S. No. 09306025, West Fork Stewart Gulch Near Rio Blanco Co.

	1974 - 1975				1976 Water Year									
	n	mean	min	max	10/7	11/17								
1. Ammonia (mg/1) (Nitrogen)	9	.01	.00	.03	.13*	.00								
2. Arsenic (ug/1)	29	1.	0	3	0	1								
3. Barium (ug/1)	28	<.56	0	220	100									
4. Bicarbonate (mg/1)	30	524	438	757	508	378*								
5. Boron (ug/1)	28	107	40	160	90	70								
6. Cadmium (ug/1)	28	1	0	2	1									
7. Calcium (mg/1)	30	90	48	130	84	57								
8. Carbonate (mg/1)	21	1	0	13	0	0								
9. Chloride (mg/1)	30	10.4	6.5	29.0	11	6.8								
10. Chromium (ug/1)	9	3	0	20	0									
11. Color (PCU)					10	12								
12. Copper (ug/1)	28	3	0	8	1									
13. Cyanide (mg/1)	9	.00	.00	.01	.00									
14. Fluoride (mg/1)	30	.2	.0	1.2	.2	.2								
15. Iron (ug/1)	30	57	0	220	100	100								
16. Kjeldahl Nitrogen (mg/1)	9	.50	.12	1.3	-	.44								
17. Lead (ug/1)	28	3	0	<20	2									
18. Lithium (ug/1)	28	5	0	20	10									
19. Magnesium (mg/1)	30	96	74	120	98	67*								
20. Manganese (ug/1)	30	5	0	20										
21. Mercury (ug/1)	29	.1	.0	.9	.0									
22. Nitrate (mg/1) as NO_3	9	.80	.00	5.7										
23. Nitrite (mg/1) as NO_2	9	.02	.00	.03										
24. Odor	15	0	0	2										
25. Oil & Grease (mg/1)	9	1	0	2										
26. Ortho-Phosphorus (mg/1) (total)	9	.01	.00	.04										
27. Potassium (mg/1)	30	3.1	.9	9.8	3	3.9								
28. Selenium (ug/1)	29	.5	0	5	0									
29. Silica (mg/1)	30	13.6	2.8	18	12	8.8								
30. Sodium (mg/1)	30	158	130	220	150	110*								
31. Solids, Dissolved (mg/1)	30	1086	943	1450	1120	782*								
32. Sulfate (mg/1)	30	490	380	590	510	340*								
33. Sulfide (mg/1)	9	.1	.0	.2	.3									
34. Turbidity (JTU)	9	8	1	16										
35. Zinc (ug/1)	28	15	0	40	10									
36. pH	28	8.3	7.4	8.9	8.5	-								

*New Extreme

Table II A-4

SURFACE WATER QUALITY
BASELINE DATA

STATION: U. S. G. S. No. 09306058 Willow Creek Near Rio Blanco Co.

	1974 - 1975				1976 Water Year									
	n	mean	min	max	10/8	11/3	12/17							
1. Ammonia (mg/1) (Nitrogen)	11	.02	.00	.11	.02	.01	.01							
2. Arsenic (ug/1)	24	1.3	0	4	1	1	1							
3. Barium (ug/1)	26	<55	0	200	0	100	200							
4. Bicarbonate (mg/1)	28	492	444	570	486	502	497							
5. Boron (ug/1)	26	118	70	140	120	100	110							
6. Cadmium (ug/1)	26	<1	0	6	1	0	1							
7. Calcium (mg/1)	28	92	64	100	94	92	94							
8. Carbonate (mg/1)	24	2	0	46	0	0	0							
9. Chloride (mg/1)	28	11.3	9.8	14	13	8.2*	8.8							
10. Chromium (ug/1)	13	<6	0	40	0	0	0							
11. Color (PCU)	11	5	3	9	5	3	2*							
12. Copper (ug/1)	26	<3	0	17	2	1	1							
13. Cyanide (mg/1)	11	.00	.00	.01	.00	.00	.00							
14. Fluoride (mg/1)	28	.4	.3	1.3	.4	.4	.5							
15. Iron (ug/1)	29	33	10	150	40	30	10							
16. Kjeldahl Nitrogen (mg/1)	11	.82	.12	3.5	-	-	.76							
17. Lead (ug/1)	26	<3.4	0	<20	3	2	1							
18. Lithium (ug/1)	26	6	0	10	10	5	0							
19. Magnesium (mg/1)	28	78	68	87	74	72	71							
20. Manganese (ug/1)	29	13	0	50										
21. Mercury (ug/1)	15	<.1	.0	.2	.0	.0	.0							
22. Nitrate (mg/1) as NO_3	11	1.3	.62	2.1										
23. Nitrite (mg/1) as NO_2	11	.02	.00	.03										
24. Odor	29	0	0	0										
25. Oil & Grease (mg/1)	11	2	0	3	0	0	0							
26. Ortho-Phosphorus (mg/1) (total)	11	.02	.01	.10										
27. Potassium (mg/1)	28	2.3	1.1	5.0	3.2	2.4	1.7							
28. Selenium (ug/1)	27	1	0	2	1	0	1							
29. Silica (mg/1)	28	16	12	18	15	14	15							
30. Sodium (mg/1)	28	130	110	180	120	110	120							
31. Solids, Dissolved (mg/1)	28	952	860	1150	901	868	910							
32. Sulfate (mg/1)	28	366	310	500	340	320	350							
33. Sulfide (mg/1)	11	.1	.0	.2	.3	.0	-							
34. Turbidity (JTU)														
35. Zinc (ug/1)	26	14	0	40	10	4	0							
36. pH	27	8.2	7.8	9.4	8.5	8.7	8.9							

*New Extreme

Table II A-5

SURFACE WATER QUALITY
BASELINE DATA

STATION: U. S. G. S. No. 09306061, Piceance Creek above Hunter Creek Near Rio Blanco Co.

		1974 - 1975			1976 Water Year									
	n	mean	min	max	10/8	11/3	12/18							
1. Ammonia (mg/l) (Nitrogen)	19	.03	.00	.09	.02	.04	.02							
2. Arsenic (ug/l)	40	2	0	6	3	1	2							
3. Barium (ug/l)	41	<70	0	<200	0	100	200*							
4. Bicarbonate (mg/l)	42	582	443	690	602	546	537							
5. Boron (ug/l)	41	200	120	320	200	200	160							
6. Cadmium (ug/l)	41	<1	0	6	0	1	0							
7. Calcium (mg/l)	42	77	59	88	84	85	82							
8. Carbonate (mg/l)	31	2	0	39	0	0	0							
9. Chloride (mg/l)	42	13	11	16	15	13	11							
10. Chromium (ug/l)	21	<4	0	40	0	0	0							
11. Color (PCU)	17	9	0	30	5	10	4							
12. Copper (ug/l)	41	<4	0	20	2	2	1							
13. Cyanide (mg/l)	19	.00	.00	.03	.00	.00	.00							
14. Fluoride (mg/l)	42	.7	.3	1.5	.5	.8	.7							
15. Iron (ug/l)	44	<65	<2	880	20	20	.0*							
16. Kjeldahl Nitrogen (mg/l)	19	1.12	.21	4.0	-	-	.24							
17. Lead (ug/l)	41	<3	0	20	2	0	1							
18. Lithium (ug/l)	41	9	0	20	10	10	10							
19. Magnesium (mg/l)	42	68	46	88	83	56	64							
20. Manganese (ug/l)	44	65	0	150	-	-	40							
21. Mercury (ug/l)	40	.03	.0	<.1	.0	.0	.1*							
22. Nitrate (mg/l) as NO_3	19	2.3	.35	3.5										
23. Nitrite (mg/l) as NO_2	19	.02	.00	.03										
24. Odor	0	0	0	0										
25. Oil & Grease (mg/l)	19	4	0	9	0	0	0							
26. Ortho-Phosphorus (mg/l) (total)	42	.03	.00	.08	.01	.03	.04							
27. Potassium (mg/l)	42	3.7	1.2	6.4	3.4	3.9	2.5							
28. Selenium (ug/l)	40	1	0	2	1	1	1							
29. Silica (mg/l)	42	17	12	20	16	16	16							
30. Sodium (mg/l)	42	152	100	200	160	120	140							
31. Solids, Dissolved (mg/l)	42	913	639	1090	1010	817	867							
32. Sulfate (mg/l)	42	290	170	380	350	250	280							
33. Sulfide (mg/l)	19	.2	.0	.5	.2	.0	.0							
34. Turbidity (JTU)	19	100	3	670										
35. Zinc (ug/l)	41	<15	0	50	10	6	10							
36. pH	41	8.2	7.5	9.2	7.7	8.6	8.7							

The Annual Summary and Trends Report contained a detailed summary of the surface-water chemistry for the C-b Tract. At this time additional data not included in the annual summary is minimal; thus, additional analysis is not presented. The interested reader is referred to the aforementioned Annual Summary and Trends Report. Surface-water quality data for the 1975 water year are presented in Tables II A-1 to II A-5. Some of the differences in values between these data and those presented in the Annual Summary and Trends Report are attributed to additional data or round-off error. These differences are not considered significant. To date in the 1976 water year several new minimum values for constituents have been recorded. Only those values recorded for November 17, 1975, at Station 09306025 appear to be significant. The third highest flow, 0.10 cfs, was recorded at this station that day, correlating with new lows for bicarbonate, sulfate, sodium, magnesium, and dissolved solids. New low concentrations recorded at other stations did not correlate with any significant change in discharge.

Water Quality of Precipitation

An attempt will be made to collect data on the quality of precipitation that falls on and about the Tract. Two stations have been designated: a nominal "upwind" station will be located near well SG-18 and a "downwind" location near well Cb-2. Samples will be collected of existing snow pack during the late winter, of precipitation from regional storms (rainfall) that typically occur during late spring and fall, and of summer thundershower-type precipitation.

Snow pack samples were collected in February, but the analytical data were not received in time for inclusion in this quarterly report.

Characterization of Sediments

Samples of sediments will be collected on major drainages affecting the Tract. They will be analyzed for physical, chemical, and mineralogical properties. Samples will be of a sufficient size to provide for present analyses and also to provide for storage and preservation for future analytical study.

Pesticides and herbicides will be determined on samples of appropriate sediment at the two stations on Piceance Creek during late summer.

Organic Fractionation of Water Samples

A new procedure for classifying the dissolved, organic carbon content of water samples will be attempted. One sample of surface water will be taken during the high flows accompanying the spring snowmelt runoff period, and one sample will be taken during the late summer low-flow period. Samples from selected wells will be analyzed also. The dissolved organic carbon content will be fractionated into: (1) hydrophobic (a) bases, (b) acids, (c) neutrals; and (2) hydrophilic (a) bases, (b) acids, (c) neutrals.

II A-2 Springs and Seeps

Table II A-6 lists those springs and seeps which have been sampled. Two springs, S-3 at the mouth of Stewart Gulch and S-9 in Willow Creek, have been selected as key locations, and will be sampled on the same schedule as the alluvial wells.

II A-3 Ground Water

Alluvial Wells

The alluvial wells have been divided into two groups with different sampling frequencies as shown in Table II A-7. For the four key wells A-1, A-3, A-6, and A-7, sampling frequency has been increased to detect any possible short-term variations in water quality during the period when conditions in the alluvium would be expected to change most rapidly. These wells will be sampled during the months of February, April, May, June, July, August, September, and November. The other wells will be sampled in May and November.

Deep Wells

Deep wells are those that are completed in and open to aquifers older than the alluvium, typically the Uinta Formation and members of the Green River Formation. These wells have been divided into two equal groups, one of which will be sampled annually, the other semi-annually. Table II A-8 lists these wells.

Ground Water Quality

The analytical schedules for ground-water quality samples have also been revised slightly. Six different analytical schedules (see Table II A-9) are involved. The complete ground-water sampling program, giving numbers of samples and the analytical schedules to be used with each, is presented in Table II A-10.

TABLE II A-6

SPRINGS

Key Springs
(Sampled Eight-Times Per Year)

1. S-3, Mouth of Stewart
2. S-9, Willow Creek

Others
(Sampled Two-Times Per Year)

1. S-1, Mouth of Stewart
2. S-2, Stewart Gulch
3. S-4, Stewart Gulch
4. S-6, PL Ranch
5. S-7, PL Ranch
6. S-10, Willow Creek

TABLE II A-7

ALLUVIAL WELLS

Key Wells
(Sampled Eight-Times Per Year)

1. A-1
2. A-3
3. A-6
4. A-7

Others
(Sampled Two-Times Per Year)

1. A-2
2. A-5
3. A-8
4. A-9
5. A-10
6. A-11
7. A-12

TABLE II A-8

DEEP WELL STRINGS

Key Strings
(Sampled Semi Annually)

1. SG-1, String 1
2. SG-1, String 2
*3. SG-6, String 1
*4. SG-6, String 2
*5. SG-6, String 3
*6. SG-8R
7. SG-9, String 1
8. SG-9, String 2
*9. SG-10A
10. SG-17, String 1
11. SG-17, String 2R
*12. SG-20

Others
(Sampled Annually)

1. AT-1C, String 1
2. AT-1C, String 2
3. Cb-1
4. Cb-2
5. Cb-4
6. SG-10R
7. SG-11, String 1
8. SG-11, String 2
9. SG-11, String 3R
10. SG-18A
11. SG-19
12. SG-21

*To be sampled for organic analysis.

TABLE II A-9

ANALYTICAL SCHEDULE #1

(STANDARD)

1. Alkalinity
2. Ammonia
3. Arsenic
4. Boron
5. Bicarbonate
6. Calcium
7. Carbonate
8. Chloride
9. Fluoride
10. Iron
11. Magnesium
12. Manganese
13. Kjeldahl nitrogen (as N)
14. Nitrate + nitrite (as N)
15. Potassium
16. Silica
17. Sodium
18. Strontium
19. Sulfate
20. Color, odor
21. Oil and grease
22. Dissolved organic carbon
23. Total dissolved solids

ANALYTICAL SCHEDULE #2

1. Aluminum
2. Beryllium
3. Barium
4. Bismuth
5. Bromine
6. Cadmium
7. Chromium
8. Copper
9. Cyanide
10. Lead
11. Lithium
12. Gallium
13. Germanium
14. Molybdenum
15. Mercury
16. Nickel
17. Selenium
18. Sulfide
19. Titanium
20. Vanadium
21. Zinc
22. Zirconium
23. Phenols

ANALYTICAL SCHEDULE #3

1. Chemical Oxygen Demand

Table II A-9 Continued.

ANALYTICAL SCHEDULE #4

1. Organic fractionation into
    a. Hydrophobic bases
    b. Hydrophobic acids
    c. Hydrophobic neutrals
    d. Hydrophilic bases
    e. Hydrophilic acids
    f. Hydrophilic neutrals

ANALYTICAL SCHEDULE #5

1. Gross alpha radioactivity. If greater than 4 pcl, then:
    a. Ra^{226}
    b. Natural uranium

2. Gross beta radioactivity. If greater than 100 pcl, then:
    a. Sr^{90}
    b. Ce^{137}

ANALYTICAL SCHEDULE #6

1. Fecal coliform

2. Total coliform

3. Methylene Blue Active Substances

4. Biological Oxygen Demand

TABLE II A-10

1976 GROUND WATER SAMPLING PROGRAM

	ANALYTICAL SCHEDULE #1	ANALYTICAL SCHEDULE #2	ANALYTICAL SCHEDULE #3	ANALYTICAL SCHEDULE #4	ANALYTICAL SCHEDULE #5	ANALYTICAL SCHEDULE #6
FEB	4 A-wells 2 springs 2 snow	4 A-wells 2 snow		2 snow	2 snow	
MAR						
APR	4 A-wells 2 springs					
MAY	12 D-wells 11 A-wells 8 springs 2 rain	12 D-wells 8 springs 2 rain	6 D-wells 2 springs 2 rain	4 A-wells 6 D-wells 4 streams 2 springs 2 rain	11 A-wells 6 D-wells 8 springs 2 rain	
JUN	4 A-wells 2 springs					
JUL	4 A-wells	4 A-wells	4 A-wells			4 A-wells
AUG	4 A-wells 2 springs 2 rain	2 rain				
SEP	4 A-wells 2 springs					
OCT						
NOV	26 D-wells 11 A-wells 8 springs	26 D-wells 11 A-wells 8 springs	26 D-wells	4 streams	26 D-wells 11 A-wells 8 springs	

II B AIR QUALITY

The current air quality/meteorology network is shown on Figure II B-1, and includes five air-quality trailers, the meteorological tower, two acoustic sounders, three ground-level mechanical weather stations, and an area-wide visibility site. Stations 020, 021, and 022 are located in the Piceance Creek Valley at Redd Ranch, Rock School, and the Gerald Oldland Ranch, respectively. Stations 023 and 024 are located on the Tract plateau. The sounders are co-located with Stations 021 and 023. The mechanical weather stations are located in the Piceance Valley in Section 9 (T2S, R97W) near Dudley Bluffs (Station 031), on the northwest corner of the Tract in Section 2 (T3S, R97W) near Scandard Gulch (Station 032), and near the southern edge of the Tract in Section 17 (T3S, R96W) near the West Fork of Stewart Gulch (Station 033). The visibility site is located off-Tract in the southwest quarter of the southwest quarter of Section 19 (T3S, R97W) along the Hunter Creek Road near Dry Gulch. The reader is referred to Tables II C-1 and II C-2 of Quarterly Data Report #5 for specific data measurements and sampling frequencies.

The air quality discussion is divided into paragraphs as follows: Air Quality and Surface Meteorology, Low Altitude Meteorology, Upper Air Studies, Visibility, Noise, and Atmospheric Diffusion Studies.

II B-1 Air Quality and Surface Meteorology

Tables II B-1 through II B-5 summarize the maximum concentrations for the gases and particulates from June through August. These concentrations listed for 5-minute, 1-hour, 3-hour, 8-hour, and 24-hour maxima and correspond to the time intervals determined by State and Federal regulations. Table II B-6 presents the frequency distribution by concentration per station for particulates and shows the geometric mean for the three months. Tables II B-7 through II B-15 tabulate the monthly maximum sliding one-hour averages. In the case of hydrocarbons and the particulates, these maxima are for the 6:00 - 9:00 a.m. interval and 24-hour period, respectively. These are shown with the corresponding date, time of day, wind direction, and speed. Monthly averages follow on Table II B-16.

The lower detectable limits for the air-quality instruments are stated to be at 5 ppb with the exception of the ozone instrument which is given as 0.5 ppb. In practice the reliable lower detectable limit for the non-methane hydrocarbons is considerably above this; these represent some of the least reliable air quality data. The C-b Tract ambient air concentrations for all the gases, except for ozone and methane, are frequently near or below the measuring instrument's minimum detectable limit. Inherent measurement inaccuracies in most air quality instruments,

(Text continued on Page 34)

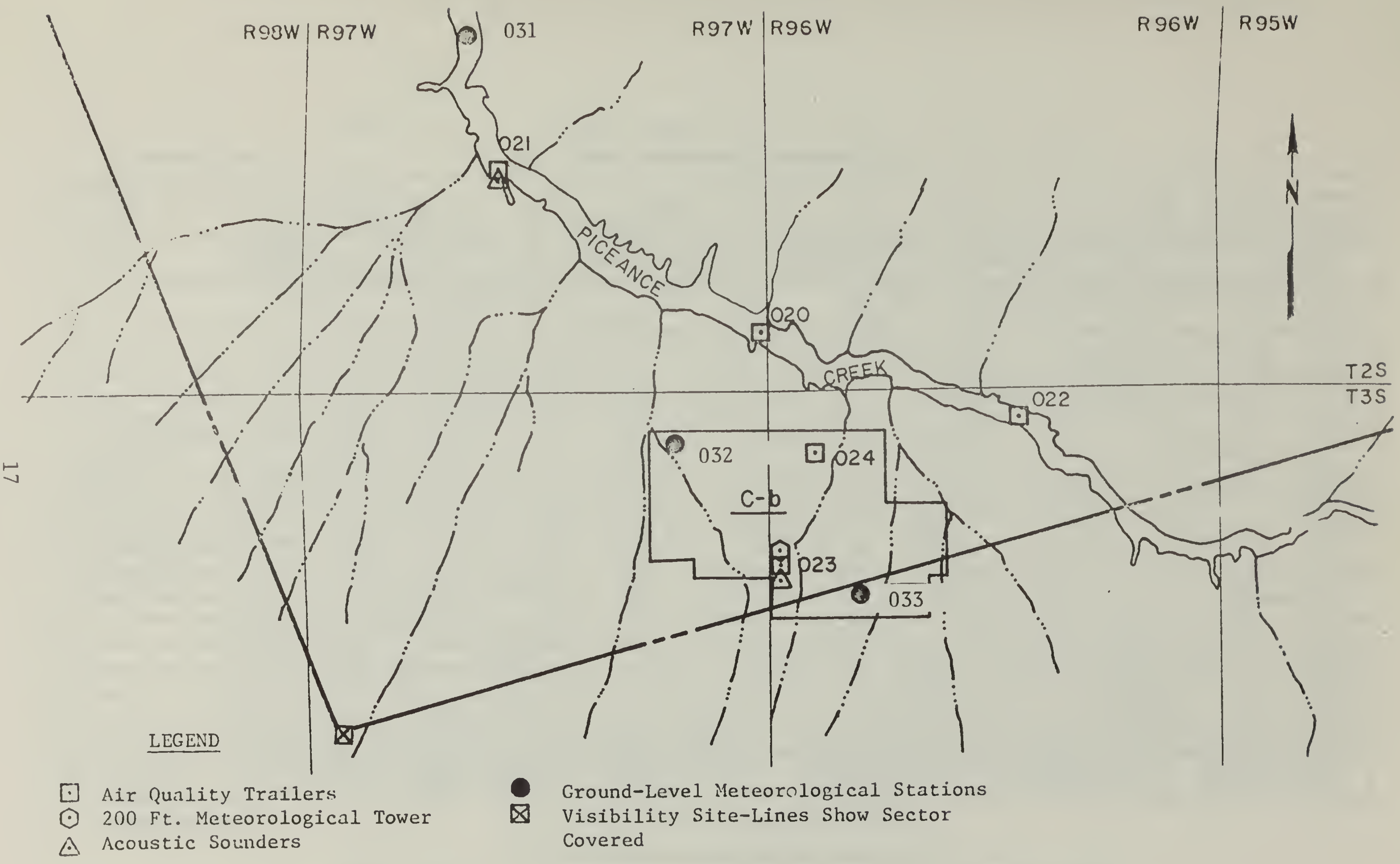


Figure II B-1 AIR QUALITY AND METEOROLOGICAL STATION LOCATIONS

Table II B-1 **QUARTERLY SUMMARY** (September 1975 - November 1975)

(Concentrations in micrograms per cubic meter)

TRAILER NO. 20

Recorded Parameter	Average	Maximum 24-hr. Concentration		Maximum 8-hr. Concentration		Maximum 3-hr. Concentration		Maximum 1-hr. Concentration		Maximum 5-min. Concentration	
		Value	Time	Value	Time*	Value	Time*	Value	Time*	Value	Time*
SO_2	0.6	8.1	10/16 12:00			18.9	10/22 6:55	20.2	10/22 8:30	109.4	10/29 11:45
H_2S	0.1							2.1	10/1 14:50	20.8	9/30 9:55
Particulates	8.9[1]	62.0	10/12								
Total Hydrocarbons	974.0					1102.5	9/18 6:00			2473.4	10/23 0:00
CH_4	922.0					1068.1	9/18 6:00			2468.2	10/23 0:00
Non-CH_4 Hydrocarbons	50.2					319.4	9/3 6:00			948.2	10/4 23:15
O_3	35.5							80.8	9/18 17:20	82.1	9/18 17:35
NO_x	9.6							51.3	9/3 6:25	89.9	10/27 0:00
NO	3.0							34.2	10/13 3:35	44.9	10/13 7:10
CO	1658.9			2722.7	10/3 0:55			2840.5	10/4 22:15	3707.3	10/4 23:40
NO_2	6.5							35.1	9/3 6:30	69.3	10/27 6:00

[1] - Geometric Mean.

*Start of interval of occurrence.

Table II B-2 QUARTERLY SUMMARY (September 1975 - November 1975)

(Concentrations in micrograms per cubic meter)

TRAILER NO. 21

Recorded Parameter	Average	Maximum 24-hr. Concentration		Maximum 8-hr. Concentration		Maximum 3-hr. Concentration.		Maximum 1-hr. Concentration		Maximum 5-min. Concentration	
		Value	Time	Value	Time*	Value	Time*	Value	Time*	Value	Time*
SO_2	1.5	17.6	10/19 11:00			19.5	10/19 22:20	20.8	10/19 23:50	41.7	10/3 23:45
H_2S	0.5							13.8	10/18 3:05	18.0	10/18 0:25
Particulates	8.8[1]	87.0	10/7								
Total Hydrocarbons											
CH_4											
Non-CH_4 Hydrocarbons											
O_3											
NO_x											
NO											
CO											

1 - Geometric Mean,

*Start of time interval of occurrence.

Table II B-3 QUARTERLY SUMMARY (September 1975 - November 1975)

(Concentrations in micrograms per cubic meter)

TRAILER NO. 22

Recorded Parameter	Average	Maximum 24-hr. Concentration		Maximum 8-hr. Concentration		Maximum 3-hr. Concentration		Maximum 1-hr. Concentration		Maximum 5-min. Concentration	
		Value	Time	Value	Time*	Value	Time*	Value	Time*	Value	Time*
SO_2	0.3	7.3	10/16 10:00			12.3	10/17 4:15	13.7	11/1 13:35	18.2	11/1 13:40
H_2S	0.2							4.2	10/5 16:50	15.2	9/1 9:30
Particulates	8.2[1]	70.0	10/7								
Total Hydrocarbons											
CH_4											
Non-CH_4 Hydrocarbons											
O_3											
NO_x											
NO											
CO											

[1] - Geometric Mean,

*Start of time interval of occurrence.

Table II B-4 **QUARTERLY SUMMARY** (September 1975 - November 1975)

(Concentrations in micrograms per cubic meter)

TRAILER NO. 23

Recorded Parameter	Average	Maximum 24-hr. Concentration		Maximum 8-hr. Concentration		Maximum 3-hr. Concentration		Maximum 1-hr. Concentration		Maximum 5-min. Concentration	
		Value	Time	Value	Time*	Value	Time*	Value	Time*	Value	Time*
SO_2	0.4	4.5	9/2 11:00			8.5	9/1 7:10	9.3	9/1 8:45	59.9	10/26 23:05
H_2S	0.8							15.1	9/4 7:45	15.2	9/4 1:30
Particulates	8.6[1]	81.0	10/7								
Total Hydrocarbons	1131.1					1631.5	11/3 6:00			3159.1	9/17 0:25
CH_4	900.6					1172.8	11/12 6:00			1677.6	10/29 9:05
Non-CH_4 Hydrocarbons	233.1					595.1	11/13 6:00			2763.2	9/17 0:25
O_3	44.9							135.3	9/7 10:00	144.6	9/7 2:10
NO_x	0.8							18.6	10/18 1:05	37.4	11/23 7:55
NO	0.2							16.5	9/14 20:05	18.7	9/14 15:10
CO	1413.3			2894.1	11/25 20:55			3157.6	11/26 1:20	4803.6	11/5 14:05
NO_2	0.6							17.5	11/18 20:40	33.7	11/23 7:55

1 - Geometric Mean, 2 -

*Start of interval of occurrence.

Table II B-5

QUARTERLY SUMMARY (September 1975 - November 1975)
(Concentrations in micrograms per cubic meter)

TRAILER NO. 24

Recorded Parameter	Average	Maximum 24-hr. Concentration		Maximum 8-hr. Concentration		Maximum 3-hr. Concentration		Maximum 1-hr. Concentration		Maximum 5-min. Concentration	
		Value	Time	Value	Time*	Value	Time*	Value	Time*	Value	Time*
SO_2	1.3	18.2	9/6 12:00			39.9	10/8 3:20	41.7	10/8 4:20	218.8	10/11 20:00
H_2S	0.6							20.9	10/8 2:20	90.0	10/11 20:25
Particulates	8.9[1]	80.0	10/12								
Total Hydrocarbons	X										
CH_4	X										
Non-CH_4 Hydrocarbons	X										
O_3	X										
NO_x	X										
NO	X										
CO	X										

1 - Geometric Mean.

*Start of time interval of occurrence.

Table II B-6

PARTICULATE CONCENTRATION FREQUENCY DISTRIBUTION
C-b SHALE OIL MONITORING PROJECT
September 1975 - November 1975

SITE	020	021	022	023	024
Concentration ug/m^3					
>260					
240-260					
220-240					
200-220					
180-200					
160-180					
140-160					
120-140					
100-120					
80-100		2		1	
60-80	1	1	2	1	2
40-60	2	0	2	0	0
20-40	11	12	8	12	11
<20*	76	76	76	77	75
TOTAL (No. of Samples)	90	91	88	91	88
Geometric (ug/m^3) Mean	8.9	8.8	8.2	8.6	8.9

* Particle sizes less than 20 ug/m^3 grouped for ease of presentation.

Table II B-7

1- HOUR MAXIMUM CONCENTRATIONS

SO_2

Constituent

By Month

Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	11.9	.2	0.0									
	Date	11/15	12/12										
	Time (MST)	18:10	1:35										
	Wind Direction (Deg.)	113	99										
	Wind Speed (MPH)	4	3										
023	Value (ug/m^3)	2.0	19.1	51.4(1)									
	Date	11/18	12/13	1/5									
	Time (MST)	12:40	7:10	11:10									
	Wind Direction (Deg.)	241	139	129									
	Wind Speed (MPH)	12	5	14									
021	Value (ug/m^3)	11.7	5.2	28.2									
	Date	11/12	12/6	1/5									
	Time (MST)	11:20	23:40	7:50									
	Wind Direction (Deg.)	298	108	132									
	Wind Speed (MPH)	4	5	6									
022	Value (ug/m^3)	13.7	13.5	16.9									
	Date	11/1	12/7	1/8									
	Time (MST)	13:35	14:35	5:10									
	Wind Direction (Deg.)	266	125	101									
	Wind Speed (MPH)	6	2	5									
024	Value (ug/m^3)	22.1	10.0	5.9									
	Date	11/7	12/14	1/1									
	Time (MST)	3:20	2:30	14:20									
	Wind Direction (Deg.)	103	291	286									
	Wind Speed (MPH)	4	9	6									

(1) Side-by-side monitoring of H_2S in Trailer 023 and of SO_2 in Trailer 021 was initiated, as a data reliability check, for three months beginning 1 January, 1976. Therefore, no SO_2 data were taken at 023. The data from the second SO_2 analyser at 021 are reported in the row for 023 for January only.

H_2S

Constituent

Table II B- 8
1- HOUR MAXIMUM CONCENTRATIONS

		1975		1976									
Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	2.0	.8	1.0									
	Date	11/10	12/12	1/24									
	Time (MST)	9:25	2:05	11:05									
	Wind Direction (Deg.)	229	57	43									
	Wind Speed (MPH)	7	2	0									
023	Value (ug/m^3)	6.9	10.0	20.5									
	Date	11/29	12/6	1/10									
	Time (MST)	8:50	8:50	15:15									
	Wind Direction (Deg.)	140	57	7									
	Wind Speed (MPH)	2	3	3									
021	Value (ug/m^3)	4.6	2.8	4.4(1)									
	Date	11/27	12/27	1/2									
	Time (MST)	9:40	11:25	8:20									
	Wind Direction (Deg.)	126	248	100									
	Wind Speed (MPH)	7	9	1									
022	Value (ug/m^3)	1.4	2.0	0									
	Date	11/25	12/14										
	Time (MST)	14:05	10:35										
	Wind Direction (Deg.)	304	271										
	Wind Speed (MPH)	7	9										
024	Value (ug/m^3)	1.3	8.2	9.8									
	Date	11/25	12/24	1/6									
	Time (MST)	13:00	10:55	6:50									
	Wind Direction (Deg.)	321	7	338									
	Wind Speed (MPH)	10	0	1									

(1) Side-by-side monitoring of H_2S in Trailer 023 and of SO_2 in Trailer 021 was initiated, as a data reliability check, for three months beginning 1 January, 1976. Therefore, no H_2S data were taken at 021 and the data from the second H_2S analyzer at 023 are reported in the row for 021 for January only.

Particulate Constituent

Table II B- 9

24- HOUR MAXIMUM CONCENTRATIONS
1975-1976
Midnight - Midnight

		1975		1976									
Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	20.0	11.0	19.0									
	Date	11/18	12/12	1/25									
	(1) 24-hr. ave. Wind Direction (Deg)	354	119	111									
	Max. 1-hr. ave. Wind Speed (MPH)	11	12	8									
	Wind Speed - 24-hr. ave. (MPH)	5	7	4									
023	Value (ug/m^3)	23.0	16.0	13.0									
	Date	11/18	12/12	1/24									
	(1) 24-hr. ave. Wind Direction	245	168	273									
	Max. 1-hr. ave. Wind Speed	19	24	14									
	Wind Speed - 24-hr. ave.	10	13	6									
021	Value (ug/m^3)	15.0	50.0	42.0									
	Date	11/10	12/14	1/4									
	(1) 24-hr. ave. Wind Direction	102	300	350									
	Max. 1-hr. ave. Wind Speed	13	14	11									
	Wind Speed - 24-hr. ave.	7	8	5									
022	Value (ug/m^3)	32.0	30.0	14.0									
	Date	11/25	12/4	1/25									
	(1) 24-hr. ave. Wind Direction	290	118	95									
	Max. 1-hr. ave. Wind Speed	12	12	10									
	Wind Speed - 24-hr. ave.	6	9	5									
024	Value (ug/m^3)	24.0	15.0	60.0									
	Date	11/27	12/12	1/25									
	(1) 24-hr. ave. Wind Direction	150	150	56									
	Max. 1-hr. ave. Wind Speed	10	19	7									
	Wind Speed - 24-hr. ave.	6	10	3									

(1) Vector Averages

Methane HC
Constituent

Table II B-10

3 - HOUR MAXIMUM CONCENTRATIONS
1975-1976
(6-9 a.m.)

		1975		1976									
Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)		678.9	698.1									
	Date	NO	12/24	1/24									
	Time (MST)		---	---									
	Wind Direction (Deg.)	DATA	57	309									
	Wind Speed (MPH)		1	2									
023	Value (ug/m^3)	1172.8	1098.2	1075.1									
	Date	11/12	12/14	1/11									
	Time (MST)	---	---	---									
	Wind Direction (Deg.)	115	312	140									
	Wind Speed (MPH)	2	12	4									
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

Non-Methane HC
Constituent

Table II B-11

3 - HOUR MAXIMUM CONCENTRATIONS
1975-1976
(6-9 a.m.)

		1975		1976									
Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)		116.7	65.3									
	Date	NO	12/5	1/24									
	Time (MST)		---	---									
	Wind Direction (Deg.)	DATA	139	309									
	Wind Speed (MPH)		8	2									
023	Value (ug/m^3)	595.1	286.4	557.8									
	Date	11/13	12/5	1/1									
	Time (MST)	---	---	---									
	Wind Direction (Deg.)	123	105	264									
	Wind Speed (MPH)	3	3	4									
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

CO
Constituent

Table II B-12

1 - HOUR MAXIMUM CONCENTRATIONS

1975-1976

		1975		1976									
Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)		501.4	568.1									
	Date	NO	12/30	1/24									
	Time (MST)		0:35	11:05									
	Wind Direction (Deg.)	DATA	87	43									
	Wind Speed (MPH)		0	0									
023	Value (ug/m^3)	3157.6	2032.9	3538.8									
	Date	11/26	12/11	1/6									
	Time (MST)	1:20	11:00	13:20									
	Wind Direction (Deg.)	89	221	302									
	Wind Speed (MPH)	0	8	11									
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

NO
Constituent

Table II B-13

1 - HOUR MAXIMUM CONCENTRATIONS

1975-1976

		1975		1976									
Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	27.8	37.8	37.8									
	Date	11/3	12/30	1/17									
	Time (MST)	5:15	3:00	21:25									
	Wind Direction (Deg.)	114	137	136									
	Wind Speed (MPH)	3	9	12									
023	Value (ug/m^3)	4.1	25.0	1.4									
	Date	11/29	12/10	1/21									
	Time (MST)	9:15	6:35	12:30									
	Wind Direction (Deg.)	205	101	331									
	Wind Speed (MPH)	2	3	2									
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

NO_2

Constituent

Table II B-14
1 - HOUR MAXIMUM CONCENTRATIONS

1975-1976

		1975		1976									
Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	29.2	23.1	34.5									
	Date	11/6	12/12	1/28									
	Time (MST)	7:45	10:40	11:55									
	Wind Direction (Deg.)	126	135	304									
	Wind Speed (MPH)	6	5	2									
023	Value (ug/m^3)	17.5	47.6	5.5									
	Date	11/18	12/9	1/5									
	Time (MST)	20:40	11:00	11:00									
	Wind Direction (Deg.)	308	13	189									
	Wind Speed (MPH)	13	2	11									
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

O_3

Constituent

Table II B-15
1 - HOUR MAXIMUM CONCENTRATIONS

1975-1976

		1975		1976									
Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	72.3	102.6	51.0									
	Date	11/7	12/13	1/11									
	Time (MST)	12:25	14:45	11:55									
	Wind Direction (Deg.)	232	121	165									
	Wind Speed (MPH)	9	4	5									
023	Value (ug/m^3)	53.4	106.0	56.3									
	Date	11/6	12/13	1/5									
	Time (MST)	14:15	22:50	3:55									
	Wind Direction (Deg.)	230	316	149									
	Wind Speed (MPH)	13	12	3									
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

Table II B-16

MONTHLY AVERAGE AMBIENT AIR CONSTITUENT CONCENTRATIONS OF GASES AND PARTICULATES (µg/m^3)

1975-1976

Trailer	Item	1975		1976									
		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	NO (µg/m^3)	2.6	3.4	12.5									
023		.0	2.5	0.0*									
020	NO_2 (µg/m^3)	8.5	2.2	4.8									
023		.8	2.6	(1)									
020	O_3 (µg/m^3)	30.9	32.7	35.7									
023		39.2	38.2	37.1									
020	Non-Methane H.C. (µg/m^3)	No Data	26.4	20.5									
023		303.8	151.3	171.2									
020	CH_4 (µg/m^3)	No Data	579.5	692.5									
023		920.6	909.6	862.5									
020	CO (µg/m^3)	No Data	(1)	408.5									
023		1847.3	(1)	1787.3*									
020	SO_2 (µg/m^3)	.0	.0	.0									
021		.9	.0	1.7									
022		.1	1.4	1.9									
023		.0	.2	1.2(1)									
024		1.1	.8	.2									
020	H_2S (µg/m^3)	.1	.0	.0									
021		.1	.2	0.2(2)									
022		.0	.1	.0									
023		.4	.9	3.3									
024		.0	.1	.4									
020	Particulate (µg/m^3)	5.0	2.8	3.2									
021		4.3	3.7	3.4									
022		4.6	2.8	3.3									
023		3.9	2.3	2.8									
024		5.3	2.5	3.3									

(1) Few or no data collected because of instrument malfunction

(2) Side-by-side monitoring of H_2S in Trailer 023 and of SO_2 in Trailer 021 was initiated as a data reliability check for three months beginning 1 January, 1976. Therefore, no SO_2 data were taken at 023 and no H_2S data were taken at 021. The data from the second SO_2 analyzer at 021 are reported in the row for 023 for January only. Data from the second H_2S analyzer at 023 are reported in the row for 021 for January only.

* 50% or Less Data

particularly at or near their lower detectable limits, necessarily make much of the air-quality data interpretation a matter of judgement and experience.

Beginning January 1, 1976, and continuing through March 31, 1976, the SO_2 instrument in Station 023 was converted to monitor H_2S; similarly, the H_2S instrument in Station 021 was changed to the SO_2 mode. Thus two identical instruments measured H_2S at Station 023, and two identical instruments measured SO_2 at 021. The purpose was to conduct a three-month test evaluating the response difference between two similar instruments measuring the same samples and calibrated with the same zero and span gases. It is expected that some knowledge of the sulfur analyzers' response precision, data reliability, and sensitivity can be obtained while operating in the harsh conditions of Tract C-b at very low ambient concentrations. Special note is made of the applicable footnotes on Tables II B-7, II B-8, and II B-16. The second SO_2 analyzer's data in Station 021 are reported (with footnote notation) in the 023 row. Similarly, the second H_2S analyzer's data in Station 023 are reported in the 021 row. This was done as a matter of convenience.

It is noted that the monthly average concentrations of H_2S differs in Trailer 023 for the month of January for the two channels by 2.9 ug/m^3. When all the data become available from this three-month test, an analysis will be made and a discussion of the results presented in Quarterly Data Report #7.

The November-through-January data, as reported in the Radian monthly data reports, show the majority of ambient sulfur dioxide (SO_2) and hydrogen sulfide (H_2S) concentrations to be below the 5 ppb minimum detectable limit of the instrumentation. Because the majority of the recorded five-minute averages appear as zeros, the computed monthly averages (Table II B-16) for these two gases are often reported as less than the stated minimum detectable limits.

The highest monthly one-hour maximum concentration for SO_2 occurred in the valley at Station 021, (Table II B-7) near Rock School during January. The highest monthly one-hour maximum concentration for H_2S occurred on the plateau at Station 023 (Table II B-8), also during January. The monthly averages for both gases (Table II B-16), as well as the one-hour maxima, are generally lower than those reported for the same months during the first baseline year. The differences, however, are not substantial and do not appear to be significant in the context of the existing data.

The bivariate frequency distributions of wind direction vs. gas concentration for SO_2 and H_2S indicate that the maximum concentrations for both of the gases at Station 024 coincide with a southerly wind direction. A similar pattern was reported in Summary Report #5 and could be interpreted as an indication that these two gases result from a common nearby source.

A paper based on the C-b ozone data entitled "Background Ozone Concentrations in Western Colorado" and co-authored by David C. Jones (Radian Corporation) and Miles D. LaHue (C-b Shale Oil Project) was presented by Dr. Jones at the Ozone/Oxidants Interaction with the Total Environment Conference in Dallas on March 11, 1976.

The following has been excerpted from this paper:

> "Having failed to establish a correlation for annual trends, we next considered the three high one-hour ozone levels for each month at each site. We tried to identify short-term air quality and meteorological effects which might accompany the high ozone levels. Parameters which were examined included solar radiation, barometirc pressure, nitrogen oxides, non-methane hydrocarbons and carbon monoxide. Increasing carbon monoxide could indicate the influx of an urban air mass, whereas a decrease might mean a dilution of the ambient air by an air mass swept down from the stratosphere during periods of turbulence. Relative humidity and average temperature also were evaluated, as was the diurnal pattern of ozone level on the days when the high levels occurred.
>
> "Of the seventy-two incidents examined, twenty-six occurred on days when no diurnal pattern was discernable. Pyranometer readings were as likely to be below the monthly average as above. The same was true for carbon monoxide and non-methane hydrocarbons. In only two cases did the month-high carbon monoxide value occur at the same time as the monthly high for ozone. The instances when nitrogen oxides were above the detection limit had no apparent relationship to the maximum ozone levels. No relationship to temperature or relative humidity could be found. Barometric pressure provided the most promising results. Frontal passages occurred on nineteen of the seventy-two days when high ozone levels occurred. Eighty-eight frontal passages occurred during the year, however, and many did not raise the ozone levels.
>
> "The final attempt to understand the ozone levels involved a study of air mass movements to determine where the air had been prior to its arrival at the monitoring sites. One period chosen for such study was May 22, 1975. The high carbon monoxide level for the month occurred on this day. Ozone was normal during the day on May 21, but began to increase that night, reaching a maximum of about 135 ug/m^3 at 8;00 a.m., May 22, at both monitoring sites. These factors indicated an influx of ozone laden air, so it was backtracked by evaluating the estimated path of the air mass. The results are shown in (Figure II B-2), where Point A represents the estimated location of the air mass thirty-six hours earlier, and the line represents its path to the monitoring sites. This air mass crossed largely remote areas, but might have crossed Grand Junction prior to its arrival at the Tract.

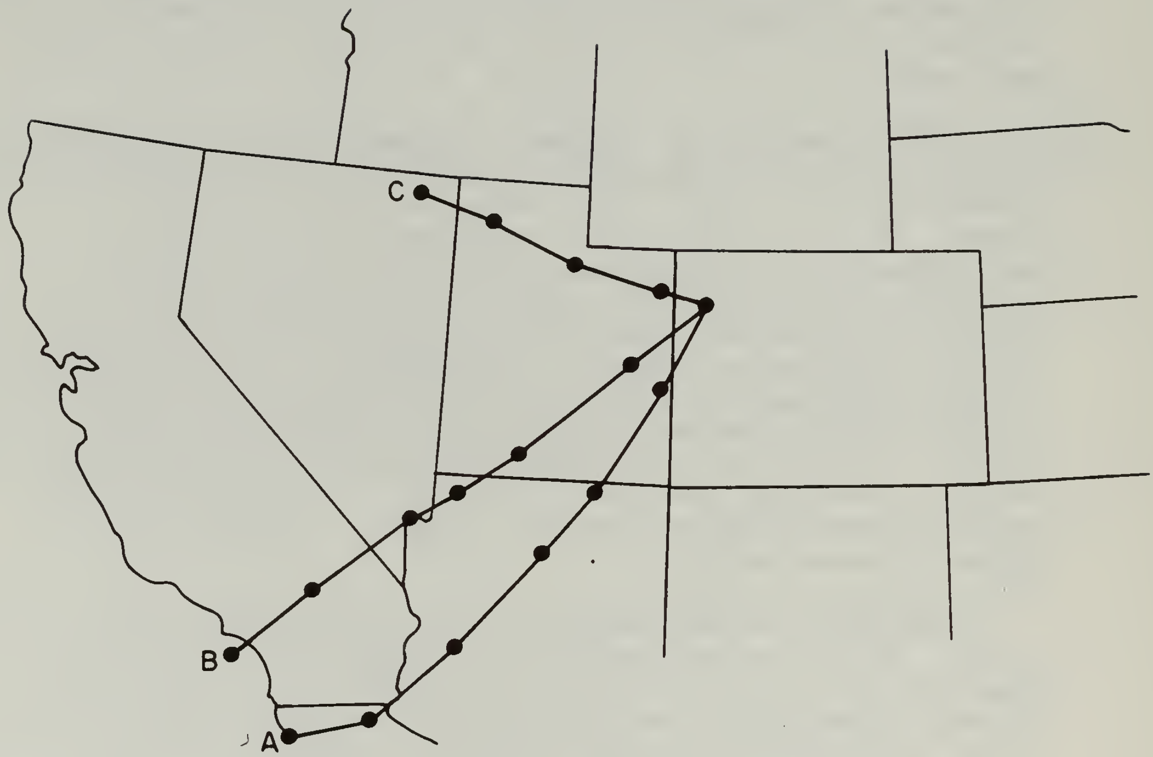


Figure II B-2   Air Parcel Trajectories

> "The next incident of interest is June 26, 1975, when the maximum hourly average for the year was observed at mid-afternoon at both monitoring sites, 160 ug/m^3 at 020 and 152 ug/m^3 at 023. The highest total solar radiation (737 langleys) of the year also occurred on this day, and both sites exhibited a strong diurnal pattern, with lows of about 50 ug/m^3 in the early morning hours. The estimated path of the air mass is also shown in Figure II B-2, beginning at point C, which is the estimated location of the air mass twenty-four hours earlier. It can be seen that this air mass passed through the Salt Lake City vicinity during the night. It is possible that ozone precursors were picked up and formed ozone (aided by the high radiation) the next day. Carbon monoxide levels were below average, however, and non-methane hydrocarbons did not vary from the average.
>
> "Another incident occurred on March 26, 1975, when high (135 ug/m^3) ozone levels occurred at both sites. Ozone levels started increasing the previous midnight at both stations and reached a maximum at 9:00 a.m. This air mass is estimated to have started thirty-six hours earlier at point B in Figure II B-2. It passed near or over Las Vegas prior to its arrival at the Tract."

This paper, in evaluating the first year of ozone measurements, arrived at the following conclusions:

1. The one-hour oxidant standard was approached even though the monitoring sites are in a remote and sparsely inhabited area.

2. High ozone levels occur in the late-winter to late-summer months. The diurnal range of concentration is small in the winter and large in the summer.

3. No correlation could be found between monthly trends or in daily trends for ozone levels and other parameters such as nitrogen oxides, non-methane hydrocarbons, solar radiation, relative humidity, suspended particulates, or to temperature.

4. Passage of fronts exhibited a weak correlation with ozone levels.

5. Based on the diurnal patterns exhibited during high ozone events and air mass movements, it appears that high ozone levels are a result of an influx of ozone-laden air and not photochemical generation at the site. For two of the instances investigated, the air masses in question may have previously crossed an urban area; nevertheless, the possibility that the ozone was naturally generated can not be precluded.

Discussion of the ozone data in previous summary reports had discounted the probability of transportation of ozone from an urban area (hereafter referred to as urban transportation). Therefore, it was surprising upon more detailed examination of the data to arrive at the above conclusions, suggesting the consequences of urban transportation of ozone and its precursors.

The conclusions reached in this paper should not be misconstrued as providing a definitive explanation as to the chemistry of the ambient-air ozone at Tract C-b. As discussed in the paper by Jones and LaHue, there are certain observed phenomena that are not amenable to analyses and interpretations as set forth here. Differences in the valley and plateau ozone concentrations and diurnal trends, seasonal trends, and with few exceptions, a diurnal trend with the maximum occurring during daylight hours are not easily explained by urban transportation. It may be that other factors, including naturally occurring photochemically reactive precursors and stratospheric and urban transportation, also influence the concentration of ozone in the Tract C-b region.

The average monthly concentrations of ozone for the November-through-January period (Table II B-16) continue at approximately the same level to which they had declined last August. The one-hour maximum concentrations (Table II B-15) for December are substantially higher than those reported for either November or January. Upon examining the diurnal tables in the Radian data report, it can be seen that at Station 020 the ozone concentration began to increase on December 12 at 1100 MST and continued through the night decreasing slightly in the early morning hours until 1000 MST on December 13. At that hour it resumed its climb to a peak at around 1600 MST and then fell off rapidly to the same concentrations approximately that had preceded this episode. On the other hand, the diurnal hourly averages for Station 023 do not reveal a similar trend, but instead, indicate the occurrence of a rather sudden peak around 2400 MST which fell off rapidly and declined to an extreme low of 4 ug/m^3 in the early morning hours of December 13. For either station there does not exist another episode similar to this during December, nor a one-hour average that approaches the monthly one-hour maximum concentration for that month. These events also suggest the transport of ozone into the Tract C-b area from an outside source.

The patterns of diurnal ozone concentration, noted in earlier reports, continue to manifest themselves at Station 020 in the valley, but they are much less obvious at Station 023 on the plateau. A similar pattern was noted last year during some of the cooler months. In addition, the substantially lower ozone levels demonstrate similar seasonal variations noted in the first year of baseline.

Natural gas operations in the vicinity of Tract C-b are a potential source of methane and non-methane hydrocarbons. Automobile traffic in the area undoubtedly affects the ambient air concentrations of NO, NO_2, methane, non-methane hydrocarbons, and CO. The effects of automobile traffic should be more evident in the reported, short-term average concentrations, i.e., one-and three-hour maximum concentration but to a much lesser extent in the long-term, monthly average concentrations. These general observations will be discussed in the following sections.

The November-through-January monthly three-hour maximum concentrations for CH_4 (Table II B-10) at Station 020 are lower and those at Station 023 are higher than concentrations reported during the first year of baseline. The monthly average concentrations (Table II B-16) for Station 020 are substantially below those reported last year and are well below the normal global background concentration range for CH_4[1]. The monthly average concentrations reported for Station 023 are similar to the first year of baseline data and roughly equivalent to global background concentrations.

High non-methane hydrocarbon (NMHC) readings which began last June, continue to be reported at Station 023 (Tables II B-11 and II B-16). It was speculated in earlier reports that the higher NMHC may be associated with the release of volatile naturally-occurring hydrocarbons arising from the increase in vegetation activity during the warmer months; however, the continuing high values reported for the November-through-January period are not amenable to this explanation (see footnote 1). During this period the valley Station 020 continued to report much lower NMHC values than those reported at Station 023 on the plateau. These monthly averages (Table II B-16) are substantially below those reported during the same time period of the first year of baseline; however, given the relatively poor precision of the NMHC analyzer, this difference is not significant.

The carbon monoxide monthly average concentration (Table II B-16) and the monthly one-hour maximum concentrations (Table II B-12) are much higher for the plateau Station 023 than those reported at the valley Station 020. In contrast the first year's baseline data indicate generally higher CO concentrations in the valley.

The nitric oxide (NO) and the nitrogen dioxide (NO_2) monthly one-hour maximum concentrations (Tables II B-13 and II B-14) and the monthly average concentrations (Table II B-16) indicate greater concentrations at the valley Station 020 than on the plateau at Station 023. This contrasts with the same period of the first year's data wherein the NO and NO_2 levels were generally higher at Station 023. This decrease in the ambient concentrations of these gases on the plateau may be attributed to the lower level of or termination of the first year's exploration activities and the associated decrease of NO and NO_2 emissions.

---

1. No obvious explanation comes to mind for this data. The commercially-available instrumentation for measuring low ambient concentrations of methane, non-methane hydrocarbons, and carbon monoxide by conversion to methane are not among the more reliable air quality analyzers. For instance, EPA tests have demonstrated inferior precision and reliability of non-methane hydrocarbon concentrations determined through the use of subtrative gas chromatography and measured with a flame ionization detector (as is employed in the C-b air quality network). None-the-less this type of instrumentation represents the present state-of-the-art.

Monthly geometric averages of particulates for the November-through-January 1976 period (Table II B-16) show substantially lower levels than the August-through-October period and seem to parallel the decreasing trend in particulate concentrations observed in the first year's data during the late fall and earlier winter months. This apparent seasonal trend may be associated with snow cover and soil moisture during these colder months. The monthly twenty-four hour maximum concentrations (Table II B-9) show the same trend with the November-through-January (1975-1976) data generally giving lower values than the preceding month of October.

Special cellulose filters, which have a low trace-element background, are used to collect particulates every sixth day at Station 023. These filters are screened for trace elements and radioactivity and analyzed as a quarterly composite to determine average concentrations (Table II B-17). A spot-check single-filter sample has been analyzed to detect any gross short-term variations from the average (Table II B-18). Table II B-19 reports the gross alpha and gross beta radioactivity in picocuries per cubic meter (pci/m^3) for both the composite and single particulate sample. The first report of these data was included as part of Quarterly Data Report #2. The second set of these data for the months of January, February, and March, as well as a correction to the first report, were included in the Quarterly Data Report #4. The third set of data covering the April, May, and June period was included in the Quarterly Data Report #5. Quarterly Data Report #6 includes the final two reports covering the periods of July-through-September and October-through-December. This completes this one-year baseline data collecting program. A final analysis and discussion will be prepared by Radian and included as part of the 7th quarter's reports. It is important to notice the corrections for several of the mercury, beryllium, and radium concentrations which were reported incorrectly in Table IV-20 and IV-21 of the Annual Summary and Trends Report.

The concentrations for these elements and the gross beta radioactivity remain well below the hazardous levels. These measured radioactivity levels are also below the 1 pci/m^3 level which is stipulated in the Conditions of Approval as the level below which further quantitative analyses is not required and can be considered to be normal background radiation.

The second year of the once-per-quarter volatile trace metal program was begun in January (Table II B-20). The first year's program has been expanded during the second year to collect data on organic mercury and particulate arsenic while selenium has been dropped. The ambient air concentrations for arsine are below the detection limit of the analytical method, similar to that found last year on January 27, 1975. Whether or not this is a seasonal trend associated with the low particulate concentrations at this time of year will be verified as additional data are collected.

In table II B-21 the particulate size distribution data are reported for the first quarter of the second year of baseline.

Data corrections to previously reported data appearing in this report are as follows:

Table II B-17

TRACE ELEMENT ANALYSES OF COMPOSITE FILTER SAMPLES ON TRACT C-b

(Concentrations in ug/m3)

	Composite Nov.-Dec. 1974	Composite Jan. - March 1975	Composite April-June 1975	Composite July-Sept 1975	Composite Oct-Dec 1975
Uranium	$7x10^{-5}$	$2x10^{-3}$	$2x10^{-4}$	< $8x10^{-5}$	
Thorium	$6x10^{-5}$		$3x10^{-4}$	$2x10^{-4}$	
Bismuth	$2x10^{-5}$	$1x10^{-4}$	$2x10^{-4}$	$4x10^{-5}$	$4x10^{-5}$
Lead	$3x10^{-3}$	$2x10^{-3}$	$5.8x10^{-3}$	$7.1x10^{-3}$	$1.2x10^{-3}$
Thallium					
Mercury	< $2x10^{-5}$	< $2x10^{-5}$	< $2x10^{-5}$	< $2x10^{-5}$	< $2x10^{-5}$
Gold					
Platinum					
Iridium					
Osmium					
Rhenium		Internal Standard	Internal Standard	< $3x10^{-5}$	Internal Standard
Tungsten	$4x10^{-5}$		*	$2x10^{-5}$	
Tantalum				$3x10^{-5}$	$2x10^{-5}$
Hafnium					
Lutecium					
Ytterhium					< $2x10^{-5}$
Thullium					
Erbium					
Holmium					
Dysprosium					

	Composite Nov.-Dec. 1974	Composite Jan. - March 1975	Composite April-June 1975	Composite July-Sept 1975	Composite Oct-Dec 1975
Terbium					
Gadolinium			$1x10^{-5}$		
Europium			$2x10^{-5}$		
Samarium			$2x10^{-4}$		
Neodymium	$4x10^{-4}$	$1x10^{-4}$	$5x10^{-4}$	$3.1x10^{-4}$	
Praseodymium	$3x10^{-5}$	$2x10^{-5}$	$2x10^{-4}$	$1.2x10^{-4}$	
Cerium	$1x10^{-4}$	$1x10^{-4}$	$4x10^{-3}$	$4.7x10^{-4}$	$2x10^{-5}$
Lanthanum	$9x10^{-5}$	$5x10^{-5}$	$1x10^{-3}$	$2.2x10^{-4}$	$3x10^{-5}$
Barium	$1x10^{-3}$	$1x10^{-3}$	$2.9x10^{-2}$	$2.4x10^{-3}$	$2.7x10^{-4}$
Cesium	$7x10^{-5}$		$1x10^{-4}$	$5x10^{-5}$	
Iodine			$8x10^{-5}$		
Tellurium					
Antimony	$5x10^{-5}$	$8x10^{-5}$	$8x10^{-5}$		
Tin	$6x10^{-4}$	$2x10^{-4}$	$2x10^{-4}$	$1.3x10^{-4}$	$4x10^{-5}$
Indium		Internal Standard	Internal Standard	Internal Standard	Internal Standard
Cadmium			$2x10^{-4}$	$6x10^{-5}$	$2x10^{-5}$
Silver	$6x10^{-4}$	$2x10^{-5}$	$2x10^{-5}$	$3x10^{-5}$	
Palladium					
Rhodium					
Radium	$6.7x10^{-10}$	$6.7x10^{-10}$	$9.1x10^{-11}$	$2.4x10^{-11}$	0.0

	Composite Nov.-Dec. 1974	Composite Jan.-March 1975	Composite April-June 1975	Composite July-Sept 1975	Composite Oct-Dec 1975
Ruthenium					
Molybdenum	$2x10^{-4}$		*	$9x10^{-5}$	$4x10^{-5}$
Niobium	$6x10^{-5}$		$2x10^{-3}$	$1x10^{-4}$	$2x10^{-5}$
Zirconium	$3x10^{-4}$		$3.8x10^{-3}$	$8.1x10^{-4}$	$1.3x10^{-4}$
Yttrium	$1x10^{-4}$	$1x10^{-4}$	$5x10^{-4}$	$1.6x10^{-4}$	
Strontium	$3x10^{-3}$	$2x10^{-4}$	$1.2x10^{-2}$	$1.9x10^{-3}$	
Rubidium	$2x10^{-3}$	$9x10^{-4}$	$5x10^{-4}$	$3.3x10^{-4}$	$1.5x10^{-4}$
Bromine		$1x10^{-4}$	$2x10^{-5}$	$2x10^{-4}$	
Selenium	$8x10^{-7}$	$6x10^{-5}$	$4x10^{-5}$	$5x10^{-5}$	
Arsenic	$1x10^{-4}$	$1x10^{-3}$	$3x10^{-4}$	$3.6x10^{-4}$	$2.9x10^{-4}$
Germanium	$3x10^{-5}$	$3x10^{-5}$	$4x10^{-5}$		
Gallium	$1x10^{-4}$	$1x10^{-5}$	$1x10^{-4}$	$6x10^{-5}$	
Zinc	$1x10^{-2}$	$9x10^{-3}$	*	$5.5x10^{-3}$	$2.9x10^{-3}$
Copper	$9x10^{-3}$	$6x10^{-2}$	$1.3x10^{-2}$	$1.2x10^{-2}$	$6.8x10^{-3}$
Nickel	$4x10^{-4}$	$3x10^{-4}$	*	$1.3x10^{-4}$	$2.3x10^{-4}$
Cobalt	$3x10^{-4}$		$3x10^{-4}$		*
Iron	$3x10^{-2}$	2.6	0.81	≈ 0.31	Maj.
Manganese	$3x10^{-3}$	$7x10^{-2}$	$8.1x10^{-3}$	$7.4x10^{-3}$	$1.6x10^{-3}$
Chromium	$7x10^{-4}$		$4.3x10^{-3}$	< $7.1x10^{-4}$	$6x10^{-5}$

	Composite Nov.-Dec. 1974	Composite Jan.-March 1975	Composite April-June 1975	Composite July-Sept 1975	Composite Oct-Dec 1975
Vanadium	$4x10^{-4}$	$2x10^{-4}$	$9x10^{-4}$	$1.1x10^{-3}$	$4.1x10^{-4}$
Titanium	$4x10^{-3}$	$6x10^{-3}$	$9.6x10^{-2}$	$3.8x10^{-2}$	$2.9x10^{-3}$
Scandium			$2x10^{-4}$	$6x10^{-5}$	$4x10^{-5}$
Calcium	.3	.44	1.2	Maj.	$4.1x10^{-2}$
Potassium	.1	.26	0.20	0.22	Maj.
Chlorine	$1x10^{-3}$		*	< $1.1x10^{-3}$	$1.7x10^{-3}$
Sulphur	$7x10^{-3}$	$6x10^{-2}$	$8.5x10^{-2}$	$3.8x10^{-2}$	$1.6x10^{-2}$
Phosphorus	$3x10^{-3}$	$4.2x10^{-2}$	$6.5x10^{-2}$	$3.1x10^{-2}$	$8.8x10^{-2}$
Silicon		.42	1.2	Maj.	Maj.
Aluminum	.1	$2x10^{-2}$	0.31	Maj.	Maj.
Magnesium	.2	3.6	0.13	0.24	Maj.
Sodium	$5x10^{-2}$	4.2	0.14	$9x10^{-3}$	Maj.
Fluorine	$1x10^{-2}$		*	$2x10^{-2}$	$4.5x10^{-2}$
Oxygen		NR	NR	NR	NR
Nitrogen		NR	NR	NR	NR
Carbon		NR	NR	NR	NR
Boron	$2x10^{-2}$		NR	NR	NR
Beryllium			$3x10^{-5}$		
Lithium	$1x10^{-4}$		3.1x10[illegible]	< $1x10^{-3}$	$6x10^{-5}$

NOTE: NR--Not reported
When no number appears, concentration is less than $1x10^{-5}$ ug/m3

* Unable to determine because of blank level.

Table II B-18

TRACE ELEMENT ANALYSES OF SINGLE FILTER SAMPLES ON TRACT C-b

(Concentrations in ug/m3)

	Single Filter Sample 12/4/74	Single Filter 1/28/75	Single Filter 4/24/75	Single Filter 7/25/75	Single Filter 11/13/75
Uranium	$5x10^{-5}$		$1x10^{-4}$		
Thorium	$3x10^{-5}$		$2x10^{-4}$	$3.3x10^{-4}$	
Bismuth	$3x10^{-5}$	$1x10^{-3}$	$2x10^{-4}$		
Lead	$1x10^{-2}$		$1.2x10^{-2}$	$7.7x10^{-3}$	$8.5x10^{-4}$
Thallium					
Mercury	$<2x10^{-5}$	$<2x10^{-5}$	$<2x10^{-5}$	$<2x10^{-5}$	$<2.2x10^{-5}$
Gold					
Platinum					
Iridium					
Osmium					
Rhenium	Internal Standard		Internal Standard		Internal Standard
Tungsten	$3x10^{-5}$		$2x10^{-6}$		
Tantalum				$3x10^{-5}$	*
Hafnium					
Lutecium					
Ytterbium					$<5x10^{-5}$
Thullium					
Erbium					
Holmium					
Dysprosium					

	Single Filter Sample 12/4/74	Single Filter 1/28/75	Single Filter 4/24/75	Single Filter 7/25/75	Single Filter 11/13/75
Terbium					
Gadolinium					
Europium					
Samarium					$<4x10^{-5}$
Neodymium	$9x10^{-5}$		$1x10^{-4}$	$1.1x10^{-4}$	$<4x10^{-5}$
Praseodymium	$7x10^{-5}$		$2x10^{-4}$	$4x10^{-5}$	
Cerium	$5x10^{-4}$	$1x10^{-4}$	$1.5x10^{-3}$	$4.7x10^{-3}$	
Lanthanum	$2x10^{-4}$	$1x10^{-4}$	$1.7x10^{-3}$	$1.8x10^{-4}$	$2x10^{-5}$
Barium	$2x10^{-3}$	$2x10^{-3}$	$1.5x10^{-2}$	$6.3x10^{-3}$	$4x10^{-5}$
Cesium	$1x10^{-4}$			$1x10^{-4}$	
Iodine		$8x10^{-4}$	$7x10^{-5}$		
Tellurium	$4x10^{-5}$				
Antimony	$2x10^{-4}$	$5x10^{-5}$	$1x10^{-4}$		$1.3x10^{-4}$
Tin	$2x10^{-3}$	$2x10^{-4}$	$2x10^{-4}$	$9x10^{-5}$	$2x10^{-5}$
Indium		Internal Standard	Internal Standard	Internal Standard	Internal Standard
Cadmium	$8x10^{-7}$	$2x10^{-4}$	$1x10^{-4}$	$2x10^{-5}$	
Silver	$1x10^{-4}$		$2x10^{-5}$		$1.5x10^{-4}$
Palladium					
Rhodium					
Radium	$14x10^{-10}$	$8.2x10^{-10}$	$2.9x10^{-9}$	$6.5x10^{-10}$	$1.7x10^{-9}$

	Single Filter Sample 12/4/74	Single Filter 1/28/75	Single Filter 4/24/75	Single Filter 7/25/75	Single Filter 11/13/75
Ruthenium					
Molybdenum	$5x10^{-4}$	$1x10^{-3}$	*	$5.4x10^{-4}$	$4x10^{-5}$
Niobium	$7x10^{-5}$	$2x10^{-5}$	$1.2x10^{-3}$	$1.9x10^{-4}$	
Zirconium	$1x10^{-3}$	$6x10^{-5}$	$3.1x10^{-3}$	$7.7x10^{-4}$	$4x10^{-5}$
Yttrium	$2x10^{-4}$	$2x10^{-4}$	$4x10^{-4}$	$1.3x10^{-4}$	
Strontium	$6x10^{-3}$	$5x10^{-3}$	$1.3x10^{-2}$	$<4.2x10^{-3}$	*
Rubidium	$4x10^{-3}$	$2x10^{-4}$	$6x10^{-4}$	$1.6x10^{-3}$	$3x10^{-5}$
Bromine	$7x10^{-5}$	$7x10^{-4}$	$4x10^{-4}$	$3.3x10^{-4}$	$5x10^{-5}$
Selenium	$8x10^{-5}$	$1x10^{-4}$	$4x10^{-4}$		$2x10^{-5}$
Arsenic	$7x10^{-4}$	$2x10^{-3}$	$3x10^{-4}$	$5x10^{-5}$	$1.2x10^{-4}$
Germanium		$2x10^{-5}$	$4x10^{-5}$		
Gallium	$5x10^{-4}$	$2x10^{-5}$	$1x10^{-4}$	$1.2x10^{-4}$	
Zinc	$2x10^{-2}$	$3x10^{-3}$	*	$5.2x10^{-3}$	$7.2x10^{-4}$
Copper	$2x10^{-2}$	$2x10^{-3}$	$3.1x10^{-3}$	$1.7x10^{-2}$	$7.8x10^{-3}$
Nickel	$3x10^{-4}$	$4x10^{-4}$	$2x10^{-4}$	$3x10^{-5}$	$1.8x10^{-4}$
Cobalt	$4x10^{-4}$		$2x10^{-4}$		*
Iron	$7x10^{-2}$	1.6	≈0.81	≈ 0.23	Maj.
Manganese	$1x10^{-2}$	$5x10^{-2}$	$1.1x10^{-2}$	$5.2x10^{-3}$	$6.7x10^{-4}$
Chromium	$1x10^{-3}$		$6x10^{-4}$	$3.7x10^{-4}$	$1.4x10^{-3}$

	Single Filter Sample 12/4/74	Single Filter 1/28/75	Single Filter 4/24/74	Single Filter 7/25/75	Single Filter 11/13/75
Vanadium	$2x10^{-3}$	$5x10^{-4}$	$2.1x10^{-3}$	$1.1x10^{-3}$	$4x10^{-4}$
Titanium	$9x10^{-3}$	$1.4x10^{-2}$	0.11	$7.7x10^{-2}$	$1.6x10^{-3}$
Scandium			$1x10^{-4}$		
Calcium	1.1	.5	≈1.7	Maj.	Maj.
Potassium	0.7	.42	0.35	0.18	0.043
Chlorine	$3x10^{-3}$		$2.4x10^{-3}$	$<7.7x10^{-4}$	0.034
Sulphur	$7x10^{-2}$	$1.8x10^{-2}$	0.24	$1.9x10^{-2}$	0.036
Phosphorus	$5x10^{-3}$	2.1	0.14	$6.1x10^{-2}$	0.025
Silicon		1.8	≈2.1	Maj.	Maj.
Aluminum	.2	.12	≈0.48	Maj.	0.045
Magnesium	0.47	3.9	0.18	.091	Maj.
Sodium	$6x10^{-2}$		0.11	$9.1x10^{-2}$	$4.5x10^{-3}$
Fluorine	$4x10^{-3}$	.25	0.016	.022	$6x10^{-3}$
Oxygen		NR	NR	NR	NR
Nitrogen		NR	NR	NR	NR
Carbon		NR	NR	NR	NR
Boron	$8x10^{-3}$	$9x10^{-3}$	NR	NR	NR
Beryllium					
Lithium	$3x10^{-4}$		$2.4x10^{-3}$	$<9.1x10^{-4}$	$1.1x10^{-4}$

NOTE: NR--Not Reported
When no numbers appear, concentration is less than $1x10^{-5}$ ug/m^3

* Unable to determine because of blank level.

Table II B-19

Gross Radioactivity (pci/m^3)

Date of Sample Collection	Gross Alpha ± Precision (1)	Gross Beta ± Precision (1)
Composite of Samples November - December 1974	$6.5 \times 10^{-4} \pm 2.7 \times 10^{-4}$ (3)	$11.4 \times 10^{-2} \pm 0.4 \times 10^{-2}$ (2)
Single Day Sample 12/4/74	$13.0 \times 10^{-4} \pm 8.0 \times 10^{-4}$	$13.2 \times 10^{-2} \pm 0.8 \times 10^{-2}$
Composite of Samples January - March 1975	$6.3 \times 10^{-4} \pm 4.1 \times 10^{-4}$ (4)	$7.1 \times 10^{-2} \pm 0.1 \times 10^{-2}$ (2)
Single Day Sample 1/28/75	$3.4 \times 10^{-4} \pm 1.3 \times 10^{-4}$	$19.6 \times 10^{-2} \pm 4.2 \times 10^{-2}$
Composite of Samples April - June 1975	$6.3 \times 10^{-4} \pm 1.1 \times 10^{-4}$	$3.1 \times 10^{-2} \pm 0.09 \times 10^{-2}$
Single Day Sample 4/24/75	$19.0 \times 10^{-4} \pm 6.0 \times 10^{-4}$	$5.0 \times 10^{-2} \pm 0.4 \times 10^{-2}$
Composite of Samples July - September 1975	$4.3 \times 10^{-4} \pm 0.75 \times 10^{-4}$	$2.3 \times 10^{-2} \pm 0.07 \times 10^{-2}$
Single Day Sample 7/25/75	$3.5 \times 10^{-4} \pm 2.3 \times 10^{-4}$	$5.5 \times 10^{-2} \pm 0.35 \times 10^{-2}$
Composite of Samples October - December 1975	$20 \times 10^{-4} \pm 1.8 \times 10^{-4}$	$2.7 \times 10^{-2} \pm 0.045 \times 10^{-2}$
Single Day Sample 11/13/75	$5.6 \times 10^{-4} \pm 2.0 \times 10^{-4}$	$1.8 \times 10^{-2} \pm 0.6 \times 10^{-2}$

(1) Variability of radioactivity disintegration process (counting error) at the 95% confidence level, 1.96 α

(2) Blank Gross Beta 0.004 ± 0.004 pci/cm^2 (420 cm^2/ filter)

(3) Blank Gross Alpha 0.0004 ± 0.0004 pci/cm^2 (420 cm^2/filter)

(4) Blank Gross Alpha 0.0007 ± 0.0006 pci/cm^2 (420 cm^2/filter)

Table II B-20 VOLATILE TRACE METAL CONCENTRATIONS - ug/m^3
ON TRACT C-b, 1976

Date of Sample Collection	Elemental Mercury(1)	Organic Mercury(1)	Arsine(2)	Particulate Arsenic(3)
January 22 & 23	0.0001	0.0476	(4)	(4)

(1) Detection limit threshold 0.0001 ug/m^3
(2) Detection limit threshold 0.5 ug/m^3
(3) Detection limit threshold 0.05 ug/m^3
(4) Below stated detection limit

Table II B-21 SIZE DISTRIBUTION OF AIRBORNE PARTICULATE MATTER IN THE RESPIRABLE RANGES

Concentrations in $\mu g/m^3$

Size Range in Microns* / Date of Sample	7.0-Above	3.3-7.0	2.0-3.3	1.1-2.0	0.01-1.1
January 22-23, 1976	2.16	1.69	1.55	1.42	1.01

*Aerodynamic diameter of the particulate matter.

The NO_2 one-hour maxima for June-through-October of 1975 were reported incorrectly in previous quarterly reports and in the annual report. Table II B-22 is a corrected version of the first-year, one-hour maxima concentration of NO_2 (Table II C-14 Summary Report #5). Tables II B-23 and II B-24 report CO one-hour monthly maxima and CO monthly averages respectively during the first year baseline data. These tables also appeared in Summary Report #5 as Tables II C-12 and II C-16, but without the August, September and October data. Corrected report pages have been submitted by Radian and are included in Quarterly Data Report #6. Corrections have been made to the first three sets of trace element data which were reported in previous quarterly reports and in Table IV-20 and Table IV-21 of the Annual Summary and Trends Report. The earlier reported values for mercury, radium, and beryllium have been corrected.

Regarding surface meteorology Tables II B-25 to II B-31 present a meteorological summary of temperature, relative humidity and winds data by month for the five trailer stations (020 through 024) and three mechanical weather stations (031 to 033) for November and December 1975 and January 1976. In addition, back data (newly reported for July-through-October 1975) are presented for the mechanical weather stations. Wind speed, direction, and temperature at a seven-foot height are presented for these stations. By virture of the logarithmic profile discussed in Summary Report #5, speeds are corrected to a 30-foot height by multiplying values obtained at a height of seven feet by a constant value of 1.421.

Average hourly temperatures for this quarterly reporting period ranged from an hourly maximum of 69° F at Station 032 on the plateau to a hourly minimum of -50° F at Station 021 in Piceance Valley. Temperature minima were up to 47°F warmer on the plateau than in Piceance Valley; maxima were only 1° F warmer on plateau than in valley. A 55° F diurnal temperature range was experienced on January 14 at Station 021 where the drainage flows are strongest.

Hourly average relative humidity for the quarter has ranged from a minimum of 16 percent to a maximum of 100 percent. Hourly averages range from 53 to 81 percent.

Five-minute maximum wind speeds have reached 39 mph in this reporting period. Hourly maxima have reached 35 mph on the plateau and 28 mph in Piceance Valley. Hourly average (arithmetic) speeds were in the four to eight mph range; monthly vector averages ranged from 1.1 to 4.3 mph. Typical monthly wind roses on the plateau and in the valley are presented in Figures II B-3 and II B-4 for Stations 023 and 021 respectively. Associated prevailing directions continue to be from the south-southwest on the plateau and from the east to east-southeast (down-valley) along Piceance Creek with the west-northwest (up-valley) direction prevailing to a lesser extent.

As stated in previous summary reports, the wind flow-field in the Tract study area is highly non-uniform. The fact that the flow is not a straight line has serious implications on the validity of continuous point-source Gaussian plume models currently in use for air-pollution

(Text continued on Page 59)

NO_2

Constituent

Table II B-22

1 - HOUR MAXIMUM CONCENTRATIONS

CORRECTIONS FOR JUNE-OCT. DATA

		1974		1975									
Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	26.7	36.0	17.6	14.4	11.2	16.7	17.0	5.1	8.0	26.8	35.1	32.9
	Date	11/26	12/3	1/25	2/1	3/19	4/18	5/10	6/1	7/31	8/17	9/3	10/22
	Time (MST)	22:30	17:10	6:35	0:45	18:40	16:20	19:45	2:30	21:05	9:05	6:30	23:40
	Wind Direction (Deg.)	95	120	106	107	137	277	127	111	24	212	145	288
	Wind Speed (MPH)	3	0	4	2	5	11	4	4	2	6	5	5
023	Value (ug/m^3)	21.2	47.0	68.2	9.2	4.8	10.1	8.0	2.0	18.7	16.1	3.3	9.5
	Date	11/26	12/6	1/16	2/23	3/23	4/28	5/1	6/5	7/12	8/10	9/1	10/18
	Time (MST)	16:00	13:10	9:15	20:10	7:10	19:40	8:35	13:40	3:15	3:40	7:40	1:05
	Wind Direction (@30')	315	57	143	179	146	60	95	311	108	108	202	130
	Wind Speed (@ 30')	7	5	4	4	4	6	5	7	1	4	12	5
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

Table II B-23

CO
Constituent

1 - HOUR MAXIMUM CONCENTRATIONS
UPDATED FOR AUG.-OCT. DATA

		1974		1975									
Trailer	Item	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	Value (ug/m^3)	1353.8	1853.7	1700.8	1716.6(2)	3680.4(2)	1811.5(2)	3296.9(2)	4650.9(2)	2065.3(2)	1714.4	1376.7	2840.5
	Date	11/14	12/15	1/11	2/19	3/16	4/11	5/29	6/4	7/29	8/12	9/29	10/4
	Time (MST)	11:55	13:30	19:30	10:05	11:25	13:35	18:20	4:55	14:55	6:50	6:10	22:15
	Wind Direction (Deg.)	113	117	341	115	147	360	126	108	219	89	105	123
	Wind Speed (MPH)	0	1	6	5	12	5	6	1	5	0	3	4
023	Value (ug/m^3)	14563.1(1)	5061.4(1)	2563.2(1)	769.7	2421.1	740.9	1155.9	790.8	1635.9	1097.3	2248.7	2474.7
	Date	11/14	12/19	1/23	2/3	3/24	4/26	5/27	6/26	7/9	8/16	9/23	10/9
	Time (MST)	15:25	4:50	17:15	15:05	13:20	7:20	17:15	22:10	11:50	15:45	10:00	6:35
	Wind Direction (Deg.)	210	246	214	202	206	39	96	114	175	350	295	115
	Wind Speed (MPH)	11	10	7	10	12	5	13	5	3	0	5	5
021	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
022	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												
024	Value (ug/m^3)												
	Date												
	Time (MST)												
	Wind Direction (Deg.)												
	Wind Speed (MPH)												

(1) Reported data are incorrect because of contaminated manifold.
(2) Reported data may be incorrect because of malfunctioning instrument.

TABLE IIB-24 MONTHLY AVERAGE AMBIENT AIR CONSTITUENT CONCENTRATIONS OF GASES AND PARTICULATES ($\mu g/m^3$)

(Updated for CO Aug-Oct data)

1974-1975

Trailer	Item	1974		1975									
		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
020	NO ($\mu g/m^3$)	1.9	0.7	3.4	*0.4	*0.3	9.6	17.8	*3.2	*0.4	9.1	*3.2	3.5
023		4.4	*12.8	14.7	0.4	*1.2	0.6	0.1	0.3	0.6	1.4	0.6	0.3
020	NO_2 ($\mu g/m^3$)	2.8	6.8	4.5	*2.5	*1.2	2.7	4.1	*0.3	*1.7	4.7	*3.0	7.9
023		2.4	*4.7	7.4	0.2	*0.4	0.9	0.5	0.0	1.5	1.0	0.1	0.7
020	O_3 ($\mu g/m^3$)	58.0	69.3	93.7	105.1	88.0	77.1	71.5	69.1	74.6	50.8	41.1	32.8
023		*31.4	28.0	42.4	85.8	85.6	90.5	87.3	84.4	86.1	61.0	53.4	43.3
020	Non-Methane H.C. ($\mu g/m^3$)	73.4	97.4	*75.7	23.4	38.6	327.6(2)	38.9	50.8	25.8	27.9	58.9	75.9
023		933.0(1)	20213.6(1)	*662.8(1)	22.1	*17.1	49.1	43.3	196.5	220.2	145.6	92.2	331.8
020	CH_4 ($\mu g/m^3$)	826.1	918.8	*908.1	879.4	829.8	590.6(2)	833.6	821.2	825.9	908.8	949.3	935.6
023		825.5	1053.8(1)	*943.6(1)	*833.7	*859.8	836.3	834.3	814.7	780.7	902.7	933.4	814.1
020	CO ($\mu g/m^3$)	553.8	676.9	908.2	1228.5(2)	1498.0(2)	*853.0(2)	1815.5(2)	1092.1(2)	206.5(2)	837.5	775.8	2514.6
023		3703.6(1)	2439.3(1)	1786.2(1)	391.4	504.5	485.8	699.9	437.0	468.5	511.0	827.9	1830.0*
020	SO_2 ($\mu g/m^3$)	0	1.8	0	0.1	1.1	0.1	0	1.0	1.6	0.9	0.7	1.4
021		1.3	1.7	0.8	0.8	0.6	1.2	1.1	2.1	1.3	1.9	1.7	1.8
022		2.6	0.1	0	0.2	0	0	0.5	1.7	0.4	0.6	0	0.6
023		0	6.4	3.3	0.1	0.6	0.5	0	0.0	0.6	2.0	0.9	0.2
024		0.2	1.7	1.3	5.5	0.9	1.1	0.7	0.6	0.1	0.9	0.7	2.0
020	H_2S ($\mu g/m^3$)	0	0	0	0	0.4	0	0	0.2	0	0	0.1	0.1
021		1.6	0	0.2	0.8	0.4	0.2	0.4	0.7	0.2	0.4	0.7	0.8
022		0.2	1.2	0	0.2	0.3	0.7	0	0.4	0.2	0.3	0.4	0.2
023		0	5.2	2.5	0.7	2.7	0.5	0.3	0.3	4.8	2.4	2.1	0
024		0	0.1	0	0.2	0.4	1.0	0.3	1.1	0.1	0.1	0.6	1.0
020	Particulate ($\mu g/m^3$)	*48.7(3)	4.3	3.3	3.8	6.5	11.6	12.4	10.7	14.7	18.6	12.8	11.2
021		*20.4	5.4	4.0	4.5	6.9	13.7	13.2	12.3	15.6	14.3	12.4	12.4
022		*35.3	4.2	2.9	3.2	5.3	11.9	11.2	9.5	14.6	11.5	12.6	9.7
023		*18.0	*6.8	*2.5	4.2	11.5	15.4	19.3	18.3	14.4	11.7	11.1	13.7
024		*117.0	2.9	2.3	3.8	4.9	10.2	11.4	8.7	11.3	10.6	9.8	12.4

* 50% Or Less Data

(1) Reported data are incorrect because of contaminated manifold.

(2) Reported data may be incorrect because of possible malfunctioning instrument.

(3) Very few particulate data points available for November 1974. The values reported were unduly influenced by the occurrence of a few unusually high 24-hour concentrations.

Table II B-25 METEOROLOGICAL SUMMARY: TEMPERATURE AND RELATIVE HUMIDITY 1975-1976

Trailer	Item	1975		1976										Annual
		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	
020	Temperature, Hourly Max. (^{o}F)	64	52	47										
021		64	50	47										
022		68	52	48										
023		63	50	47										
024		64	51	52										
020	Temperature, Hourly Min. (^{o}F)	-17	-14	-42										
021		-21	-27	-50										
022		-18	-12	-36										
023		4	6	- 6										
024		- 7	- 5	-26										
020	Temperature, Hourly Avg. (^{o}F)	26	22	16										
021		24	19	12										
022		27	21	17										
023		32	28	24										
024		26	23	22										
020	Rel. Hum., Hrly Max. (%)	100	98	99										
021		100	100	100										
022		100	100	100										
023		100	90	90										
024		100	98	100										
020	Rel. Hum., Hrly Min. (%)	16	32	28										
021		19	36	35										
022		22	35	33										
023		19	34	25										
024		22	32	29										
020	Rel. Hum., Hrly Avg. (%)	61	73	70										
021		70	81	78										
022		66	77	74										
023		53	62	62										
024		58	67	67										

Table II B-26 METEOROLOGICAL SUMMARY : TEMPERATURE* 1975

MRI STATION	ITEM	1974		1975										ANNUAL
		NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	
031	Temperature Hourly Max. (^{O}F)	---MRI STATIONS NOT OPERATIONAL PRIOR TO JULY---								91	93	88	83	
032										96	99	92	82	
033										89	93	88	80	
031	Temperature Hourly Min. (^{O}F)									39	27	13	0	
032										43	37	20	6	
033										47	40	26	6	
031	Temperature Hourly Avg. (^{O}F)									66	62	51	39	
032										68	66	54	45	
033										68	66	57	45	

*Temperature at 7 feet.

Table II B-27 METEOROLOGICAL SUMMARY: TEMPERATURE
1975-1976

MRI STATION	ITEM	1975		1976										ANNUAL
		NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	
031	Temperature Hourly Max. (°F)	66	52	48										
032		69	56	44										
033		67	52	53										
031	Temperature Hourly Min. (°F)	-10	-10	-23										
032		- 9	- 5	-19										
033		- 3	- 4	- 8										
031	Temperature Hourly Avg. (°F)	22	20	15										
032		27	23	15										
033		29	23	21										

Table II B-28 METEOROLOGICAL SUMMARY: WIND SPEED & DIRECTION 1975-1976
(30 Foot Height)

Trailer	Item	1975		1976										Annual
		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	
Tower 200'	Wind Speed, 5-Min. Max. (MPH)	39	37	35										
	& Associated Direction (Deg.)	308	200	198										
020	Wind Speed, Hourly Max. (MPH)	16	14	13										
021		20	17	14										
022		16	18	15										
023		33	25	27										
024		28	21	21										
020	& Associated Direction (Deg.)	147	104	140										
021		316	98	126										
022		114	281	116										
023		176	192	202										
024		188	183	187										
020	Wind Speed, Hourly Avg. (MPH)	5	5	5										
021		5	5	5										
022		6	6	6										
023		7	6	5										
024		6	5	4										
020	Wind Direction Hourly Avg. (Deg.)	117	112	110										
021		100	88	80										
022		119	110	106										
023		205	173	195										
024		144	116	121										

Table II B-29

METEOROLOGICAL SUMMARY: WIND SPEED AND DIRECTION*
1975-1976

MRI STATION	ITEM	1975		1976										ANNUAL
		NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	
031 032 033	Wind Speed, Hourly Max. (MPH) &	28 17 35	28 19 28	28 15 28										
031 032 033	Wind Direction (Deg.) Associated w/Max. Reading	344 191 136	150 272 156	167 194 221										
031 032 033	Wind Speed, Hourly Ave. (MPH)	7 6 8	6 5 7	6 6 7										
031 032 033	Wind Direction, Hourly Ave. (Deg.)	182 170 184	211 148 163	206 157 190										

* Speed @ 30'; Direction @ 7'

Table II B-30 METEOROLOGICAL SUMMARY; WIND SPEED & DIRECTION* 1975

MRI STATION	ITEM	1974		1975										ANNUAL
		NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	
031	Wind Speed, Hourly Max. (MPH) &	-------------MRI STATIONS NOT OPERATIONAL PRIOR TO JULY-------------------								15	13	28	27	
032										14	20	28	28	
033										16	16	28	43	
031	Associated Direction (Deg.)									255	150	136	167	
032										120	315	275	180	
033										135	270	260	133	
031	Wind Speed, Hourly Avg. (MPH)									4	4	5	7	
032										4	5	6	6	
033										5	6	7	9	
031	Wind Direction, Hourly Avg. (Deg.)									196	190	198	204	
032										146	155	172	168	
033										155	166	193	171	

*Speed @30 feet; direction @7 feet.

Table II B-31 PRELIMINARY CORRELATION OF WIND SPEED & DIRECTION
JANUARY 1976 - HOURLY-AVERAGE VALUES

		Regime 2										Hour	Regime 1								Regime 2					
Item	Station	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Mean
SPEED (MPH)	024	4	5	5	5	4	5	5	5	4	3	3	4	5	5	5	5	5	5	4	4	4	4	4	4	4
	023	5	4	4	4	4	4	4	4	4	4	5	6	7	7	7	7	7	6	6	6	5	5	4	4	5
	024 -023	-1	1	1	1	0	1	1	1	0	-1	-2	-2	-2	-2	-2	-2	-2	-1	-2	-2	-1	-1	0	0	-.7
	Mean of Diff.	0											-1.9													
DIR. (DEG.)	024	117	112	116	121	117	116	115	109	107	92	72	245	266	264	250	222	213	193	97	116	96	124	120	117	147
	023	177	178	194	175	171	175	180	169	164	129	210	279	264	266	255	251	237	218	207	195	193	184	176	186	201
	024 -023	-60	-66	-78	-54	-54	-59	-65	-60	-57	-37	-138	-34	+2	-2	-5	-29	-24	-25	-110	-79	-97	-60	-56	-69	-54.8
	Mean of Diff.	-63.4											-16.7													

Note: Both stations on Tract
≈ 1-3/8 miles apart

Figure II B-3 STATION 023 30' ELEVATION WIND ROSES ('75-'76)

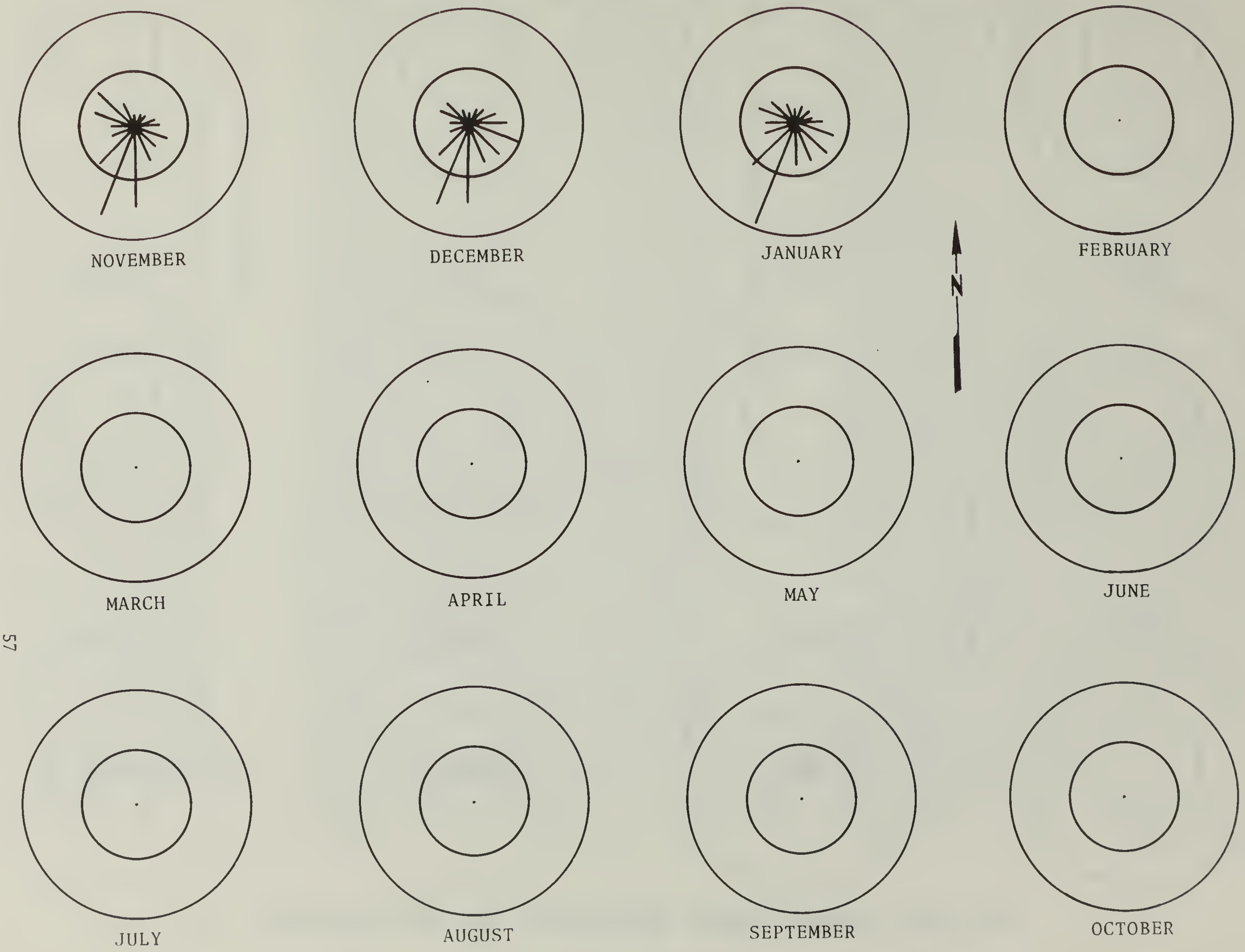
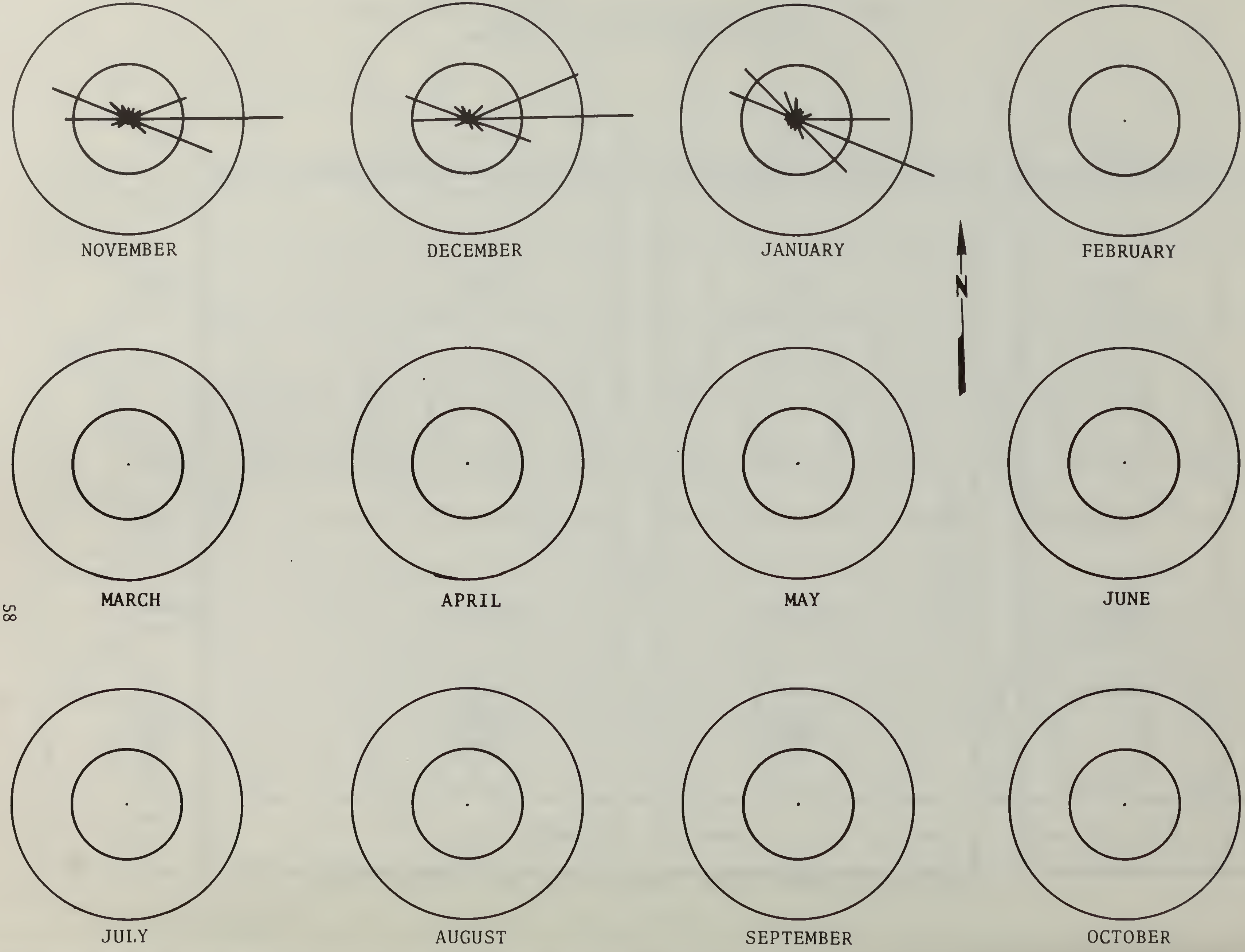


Figure II B-4 STATION 021 30' ELEVATION WIND ROSES ('75-'76)



dispersion analysis including those models used by Federal and State agencies. Surface flows (30-foot height) for the Piceance Creek stations generally follow the Creek directions (east-southeast for downstream and west-northwest for upstream). For Station 023 on the plateau the prevailing direction is from the south-soutwest; 024 exhibits a transitional flow from plateau-like to valley-like conditions. Table II B-31 portrays a preliminary correlation of Station 024 with 023 with regard to wind speed and direction for the month of January, 1976, utilizing hourly-average values. The mean hourly average value for speed at 024 is 0.7 mph less than that at 023. The mean direction at 024 is 147°; the mean direction at 023 is 201°. These stations are roughly 1-3/8 miles apart. Table II B-31 has been blocked into time regimes corresponding approximately to times of up-plateau flow (1200 to 1800 MST) and down-plateau flow (2000 to 1000 MST). Transitional diurnal flows occur near 1100 MST and 1900 MST. For the down-flow regime, there is no difference in the mean wind speed, but the mean direction varies by 63.4°. For the up-flow regime the average wind speed at 023 is 1.9 mph greater than that at 024 with 16.7° difference in direction as noted. Further flow-field analysis is underway.

II B-2 Low Altitude Meteorology

The quarterly wind rose at the 100-foot level on the meteorological tower (Figure II B-5) indicates that the prevailing wind direction is from the south-southwest for the September-through-November quarter (as reported in Radian's latest quarterly report), which is similar to both the previous quarter and to the annual rose for the first year of baseline as presented in the Annual Summary and Trends Report.

Pasquill-Gifford stability class frequencies are as obtained from temperature-difference data on the tower, i.e., 200-foot. level minus 30-foot. level, Table II B-32. Average hourly stability classes are obtained from the same tower source and from the pyranometer at Station 023 (Table II B-33). (The pyranometer yields information only during daylight hours.) Class A stability from 1100-1700 MST for these winter months is obtained for the lower elevations from the tower. The more stable C-class is obtained from the pyranometer calculation which approximated an integrated value through height extremes higher than tower-top values for the same diurnal range. Agreement between the two techniques is close for the early-morning and late-afternoon segments of the day.

II B-3 Upper Air Studies

The characteristics of temperature inversions have been studied since the fall of 1974; their presence and associated altitude are important in that they bear on the extent and degree of turbulent mixing available between potential pollutant plumes and the atmosphere. Continuous data gathering from two acoustic sounders has been accomplished and reported by Marlatt and Associates in Reference 11 of Quarterly Data Report #6. Two analyses of previous data were also conducted and were reported in Quarterly Data Report #6 (QDR #6). These are a statistical comparison of the frequency of inversions as obtained from aircraft and

Figure II B-5

QUARTERLY WIND ROSE - 100' LEVEL
SEPT. '75 - NOV. '75

TOTAL % OF CALMS DISTRIBUTED (0.37 %)
TOTAL NO. OF 5-MIN. SAMPLES - 22932

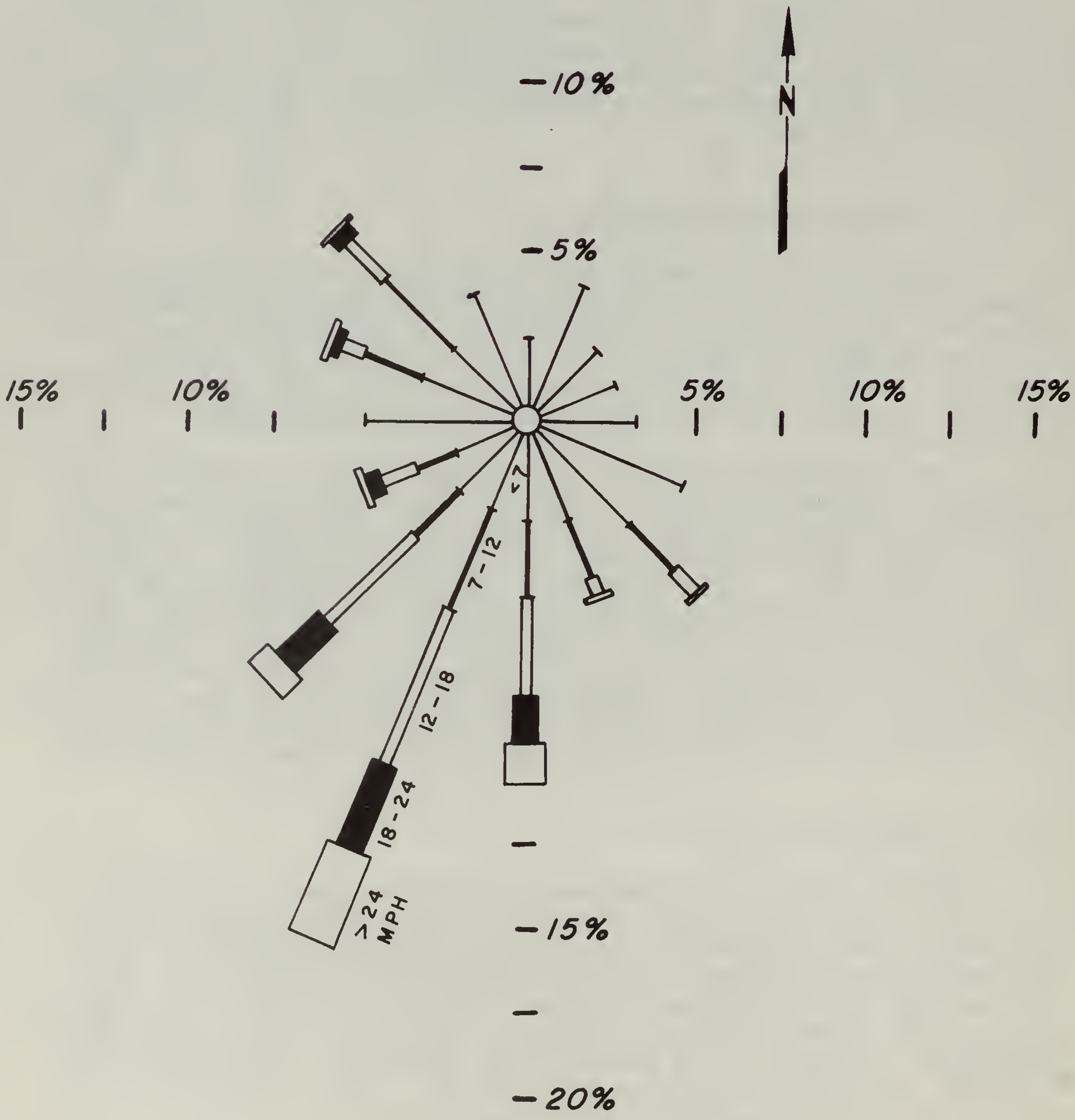


Table II B-32 METEOROLOGICAL SUMMARY: STABILITY CLASS FREQUENCIES (%)
1975-1976

Source: Met. Tower
(30' to 200')

Pasquill-Gifford Stability Class	dT/dz Range for this Stability Class ($^oC/100m$)	1975		1976										Annual
		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	
A	<-1.9	51.7	47.1	52.9										
B	-1.9 to -1.7	1.3	4.1	2.5										
C	-1.7 to -1.5	2.1	4.5	2.6										
D	-1.5 to -0.5	10.4	13.0	10.6										
E	-0.5 to +1.5	21.9	23.3	19.7										
F	>1.5	12.6	8.0	11.7										
Total		100.0	100.0	100.0										

Table II B-33 AVERAGE HOURLY STABILITY CLASSES, 1975-1976

SOURCE: TEMPERATURE DIFFERENCES BETWEEN 200 FT. AND 30 FT. ON THE MET. TOWER

Month	Hour																								Average
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
Nov.	D	D	D	D	D	D	D	D	C	A	A	A	A	A	A	A	A	C	D	C	D	D	D	D	C
Dec.	D	D	D	D	D	D	D	D	C	C	A	A	A	A	A	A	A	C	C	C	C	D	D	D	C
Jan. '76	D	D	D	D	D	D	D	D	D	C	B	A	A	A	A	A	A	B	C	C	C	C	C	D	C
Feb.																									
Mar.																									
Apr.																									
May																									
June																									
July																									
Aug.																									
Sept.																									
Oct.																									

SOURCE: PYRANOMETER (DAYLIGHT ONLY)

Month	Hour												
		7	8	9	10	11	12	13	14	15	16	17	18
Nov.			C	C	C	C	C	C	C	C	D	D	
Dec.			C	C	C	C	C	C	C	C	D	D	
Jan. '76			C	C	C	C	C	C	C	C	D	D	
Feb.													
Mar.													
Apr.													
May													
June													
July													
Aug.													
Sept.													
Oct.													

acoustic sounders (Reference 12, QDR #6) and a preliminary study of the representativeness of 15-days per quarter of temperature-inversion data (Reference 13, QDR #6). Relative merits of both the aircraft and acoustic sounder programs are presented on Table II B-34; both systems together provide information not available with either system alone.

Inversion characteristics are reported from acoustic sounders at Stations 021 and 023. Table II B-35 lists the number of inversions recorded and their means and standard deviations with respect to duration, maximum, minimum, and average heights for each operational month. Heights do not refer to bottom and top of the inversion layers but to the maximum and minimum heights of the top of the inversion layer over the duration of the inversion. Measurements were obtained at Station 023 on the plateau from 1 September 1975 to 19 February 1976. Inversions occurred on 117 of the 143 days (82%). During this time period at Station 021 in the valley, measurements were obtained on only 58 days; 53 days (91%) had inversions. Forty-seven percent of the plateau inversions were less than a 10-hour duration; forty percent of the valley inversions were less than 10 hours. Eighty-two percent of the inversions at 023 were less than 16 hours; sixty-four percent of the inversions at 021 were less than 16 hours. Highest frequencies of occurrence for onset times of inversions occurred from 1600 to 1730 MST in the valley and from 1730 to 1900 MST on the plateau. Highest frequencies for inversion breakup occurred from 1000 to 1130 MST for both locations.

Comparison of aircraft and sounder data over three 15-day overlapping periods in 1975 is summarized for previously published data on Table II B-36 and is summarized for best agreement of pooled data between the previously published data and the author's reinterpretation of this data on Table II B-37. This reinterpretation was subject to the following criteria: 1) at least +1°C increase in temperature for a 300-foot increase in altitude for the aircraft data constituted an inversion; and 2) a 300-foot maximum difference inversion height, as recorded by sounder and aircraft, constituted agreement. Five classes were determined and examined, to wit: Class 1 - both sources agreed that there was no inversion; Class 2 - both agreed within 300 feet (for reinterpreted case as opposed to ± 250 feet for previously-published case) that there was an inversion; Class 3 - both agree there is an inversion but greater than 300-foot disparity in altitude; Class 4 - sounder indicates presence of inversion but aircraft does not; Class 5 - aircraft indicates presence of inversion but sounder does not. Sample proportion of agreement (p) is indicated for each quarter and for all quarters in Tables II B-36 and II B-37. Statistical tests in Reference 12 of QDR #6 show that the winter quarter data are significantly lower in agreement than summer data and that no difference exists between spring and summer data; this provides a basis for treating spring and summer data as a combined sample to test the hypothesis of 90 percent and 95 percent proportion of agreement between aircraft and sounder inversion data at a five percent level of significance. These tables show that by pooling the published data and reinterpreted data and searching for best agreement, the best estimate of agreement between the sounder and aircraft is 96 percent. One would accept the hypothesis of 95 percent agreement at the 5 percent level of significance. Furthermore, for classes two-through-five (where at least

Table II B-34 RELATIVE MERITS OF AIRCRAFT vs. ACOUSTIC SOUNDER FOR OBTAINING TEMPERATURE-INVERSION DATA

	Advantages	Disadvantages
Aircraft	1) Relative ease of interpretation of data 2) Definition of the entire thermal profile to 13,000-foot elevation	1) Data obtained in rough terrain only in daytime 2) Vertical profile is actually 1-km diameter helix 3) Obtaining near-surface data is risky 4) Relatively high cost of operations
Acoustic Sounder	1) Continuous data collection 2) Near-instantaneous response 3) Relatively low cost of operations	1) Difficulty of interpretation of sounder records 2) Equipment reliability 3) Snow on dish causes malfunction 4) About a 1000-meter maximum range 5) Constant speed of sound assumption causes small error in time of echo return (3%)

Table II B-35 MEANS AND STANDARD DEVIATIONS OF INVERSION DURATIONS AND MAXIMUM, MINIMUM AND AVERAGE INVERSION HEIGHTS BY MONTH AS OBTAINED FROM ACOUSTIC SOUNDERS

Station	Month	Number of Days of Measurement	Number of Inversions Recorded	Inversion Duration (Hrs)		Maximum Inversion Heights (Ft)		Minimum Inversion Heights (Ft)		Average Inversion Heights (Ft)	
				Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
023	Sept. 1975	29	29	8	5	828	256	244	119	500	161
	Oct.	20	18	11	4	623	200	197	76	414	152
	Nov.	22	20	10	7	620	320	204	205	399	273
	Dec.	30	38	13	8	917	514	319	225	596	335
	Jan. 1976	24	25	13	9	806	405	266	254	521	345
	Feb.[1]	18	15	11	5	1186	709	343	253	704	380
021	Sept. 1975	0									
	Oct.	0									
	Nov.	73	35	14	6	780	292	266	175	574	217
	Dec.	10	18	11	5	779	216	317	186	553	175
	Jan. 1976	18	32	10	5	1145	345	497	238	849	270
	Feb.[1]	7	5	20	11	1348	572	315	183	873	255

---

1. Through February 19, 1976

Table II B-36

STATISTICAL ANALYSIS OF PUBLISHED AIRCRAFT AND ACOUSTIC SOUNDER INVERSION DATA

CLASS	JAN. FEB. 1975	APRIL MAY 1975	JULY 1975	TOTAL	TOTAL PERCENT
1. Agree No Inversion	24	30	26	80	64.5
2. Agree Inversion ± 250 ft.	6	2	4	12	9.7
3. Disagree On Inversion Height	5	1	0	6	4.8
4. Inversion by Sounder Not by Aircraft	12	6	1	19	15.3
5. Inversion by Aircraft Not by Sounder	3	0	4	7	5.6
Total Comparisons	50	39	35	124	99.9

	Winter	Spring	Summer	Total	Spring Summer
Sample Size = N	50	39	35	124	74
Sample Proportion of Agreement = p	.600	.821	.857	.742	.838
Standard Deviation $S = \sqrt{p(1-p)/N}$	.0693	.0615	.0591	.0393	.0428
Test Hypothesis: $p_o = 0.95$ p_o = True Proportion: $\alpha = 0.05$	Reject	Reject	Accept	Reject	Reject
Test Hypothesis: $p_o = 0.90$ p_o = True Proportion: $\alpha = 0.05$	Reject	Accept	Accept	Reject	Accept

Table II B-37

STATISTICAL ANALYSIS OF AIRCRAFT AND ACOUSTIC SOUNDER TEMPERATURE INVERSION DATA BASED ON BEST AGREEMENT FROM ALL DATA

CLASS	JAN. FEB. 1975	APRIL MAY 1975	JULY 1975	TOTAL	TOTAL PERCENT
1. Agree No Inversion	24	30	27	81	60.9
2. Agree Inversion ± 300 ft.	15	14	9	38	28.6
3. Disagree On Inversion Height	4	0	1	5	3.8
4. Inversion by Sounder Not by Aircraft	7	1	0	8	6.0
5. Inversion by Aircraft Not by Sounder	0	0	1	1	0.7
Total Comparisons	50	45	38	133	100.0

	Winter	Spring	Summer	Total	Spring Summer
Sample Size = N	50	45	38	133	83
Sample Proportion of Agreement = p	.780	.978	.947	.895	.964
Standard Deviation $S = \sqrt{p(1-p)/N}$	.0586	.0220	.0362	.0266	.0205
Test Hypothesis: p_o = True Proportion: $p_o = 0.95$ $\alpha = 0.05$	Reject	Accept	Accept	Accept	Accept
Test Hypothesis: p_o = True Proportion: $p_o = 0.90$ $\alpha = 0.05$	Accept				Reject

α = Level of significance = probability of rejecting true hypothesis.

one source said there was an inversion), the agreement on inversion height to within ± 300 feet is three out of four for the pooled data. This study has provided sufficient confidence for the continued use of the acoustic sounder at the C-b Tract.

Using acoustic sounder data for the same three quarters of 1975, the probability of occurrence as a function of time of day and expected duration and height of the inversion have been investigated in Reference 13, QDR #6; results are summarized on Figures II B-6, 7, 8, and 9 by month and by quarters. It is to be noted that when the probability of occurrence of an inversion is ≥0.5, an inversion is expected to occur, i.e., expected durations were obtained for segments of the probability-of-occurrence curve ≥0.5. In addition, the question of representativeness of a 15-day period of data to the complete quarter is addressed for two cases: 1) continuous data over the 15-day period; and 2) discrete data over the 15-day period corresponding to a maximum of four flights per day for which the aircraft data was obtained. This second purpose is based on the premise of "reasonable" agreement and equivalence between sounder and aircraft as discussed above. These comparisons are shown on Figures II B-7, 8, 9, and 10. Results of this preliminary study are as follows: Only the 15-day sample of continuous data for the winter quarter is representative of data for the entire quarter with regard to probability of occurrence and mean altitude of inversions. Discrete samples four times per day during daylight hours (corresponding to aircraft flight times) for 15 days per quarter do not provide adequate information to construct diurnal curves of probability of occurrence, duration, or height of inversion; these samples show agreement with quarterly average values in seven of twelve instances.

II B-4 Visibility Study

The location of the views used in this study and their orientation to Piceance Creek and Tracts C-a and C-b are shown in Figure II B-11.

Fluctuations in the daily mean visual-range at the four views were generally similar. An increase or decrease in the daily mean visual-range for an individual view was generally marked by a similar response in the remaining views. During January, however, similarity of view response was not as evident as in December and February; the daily mean visual-ranges of the views varied considerably. This is most evident for View II whose mean visual-range remained low while the visual-ranges in the remaining views increased during the middle of the month. Also during January, comparable daily fluctuations in the mean visual-ranges of the views did not occur. On January 8, 1976, for example, the distant objects in View II, as reported in the Site Log and evidenced by the photography, were obscured all day, resulting in a mean visual-range much lower than the remaining views.

Days of low mean visual-ranges, such as December 14, 1975, January 2, and February 7, 1976, were generally characterized by haze or passing snowstorms. On December 14, 1975, for example, blowing snow restricted visibility to less than one mile during the morning and early afternoon

Figure II B-6 PROBABILITY OF INVERSION AS FUNCTION OF HOUR OF DAY

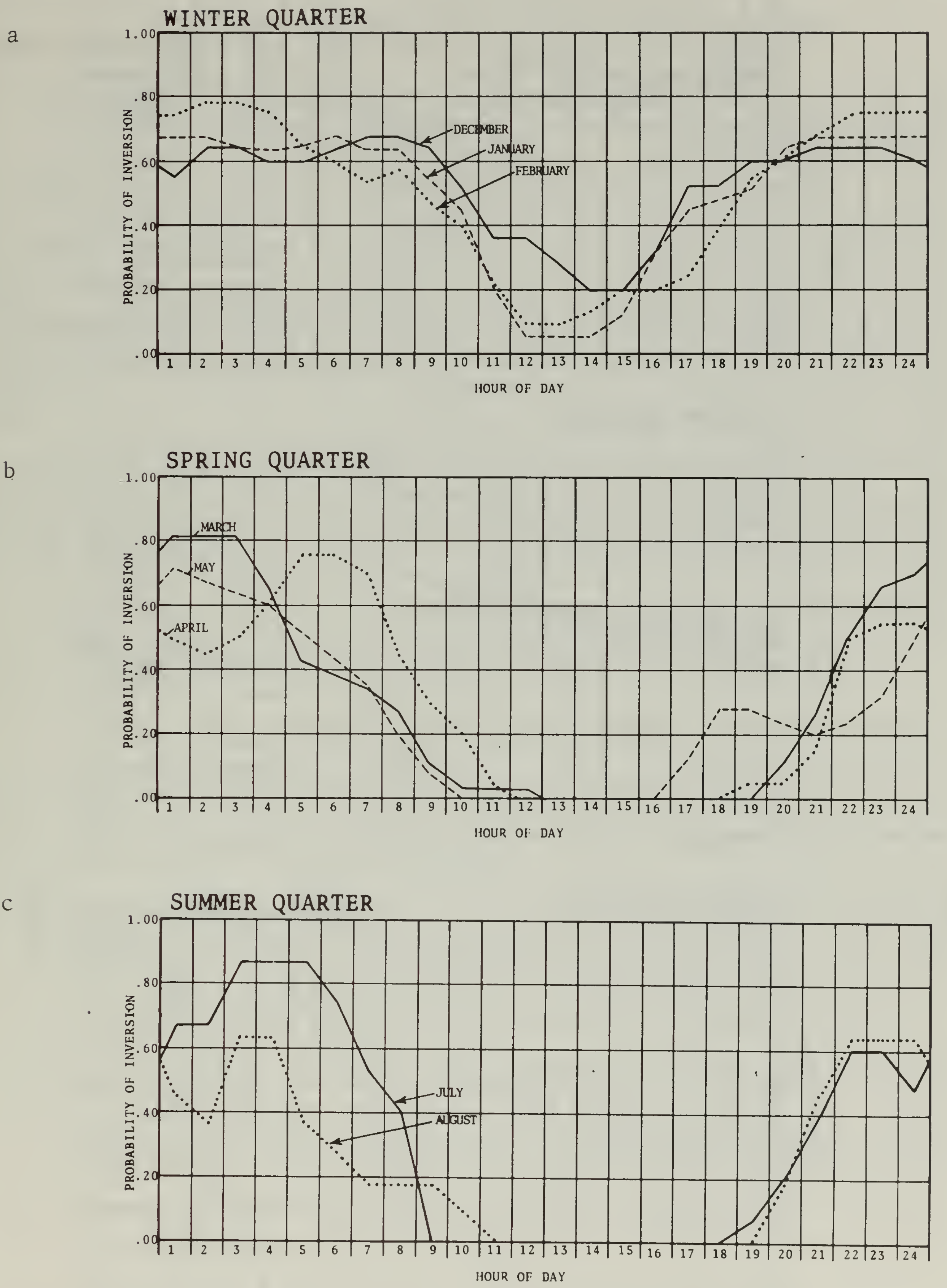
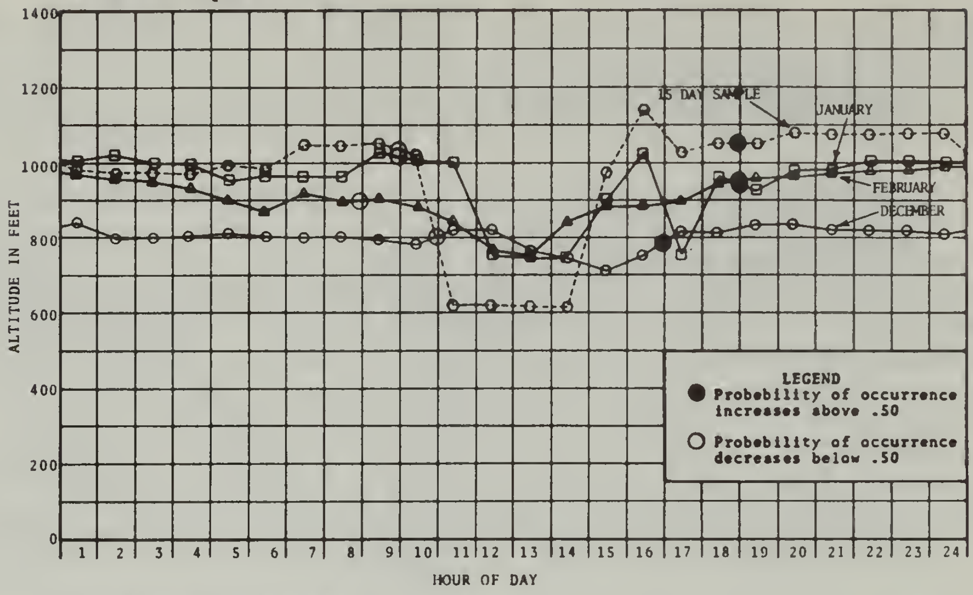


Figure II B-7

ALTITUDE VERSUS HOUR OF DAY

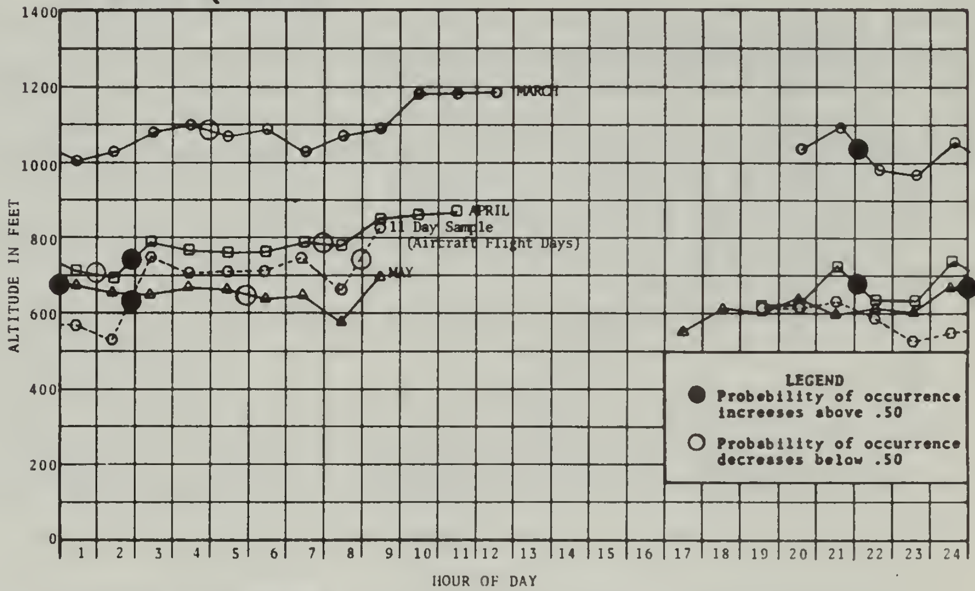
a

WINTER QUARTER



b

SPRING QUARTER



c

SUMMER QUARTER

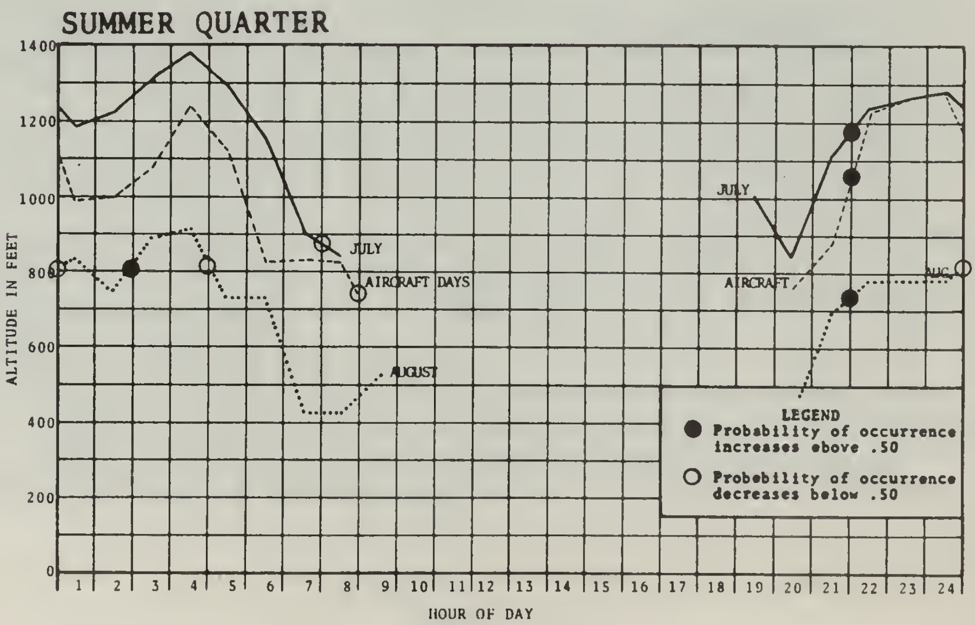
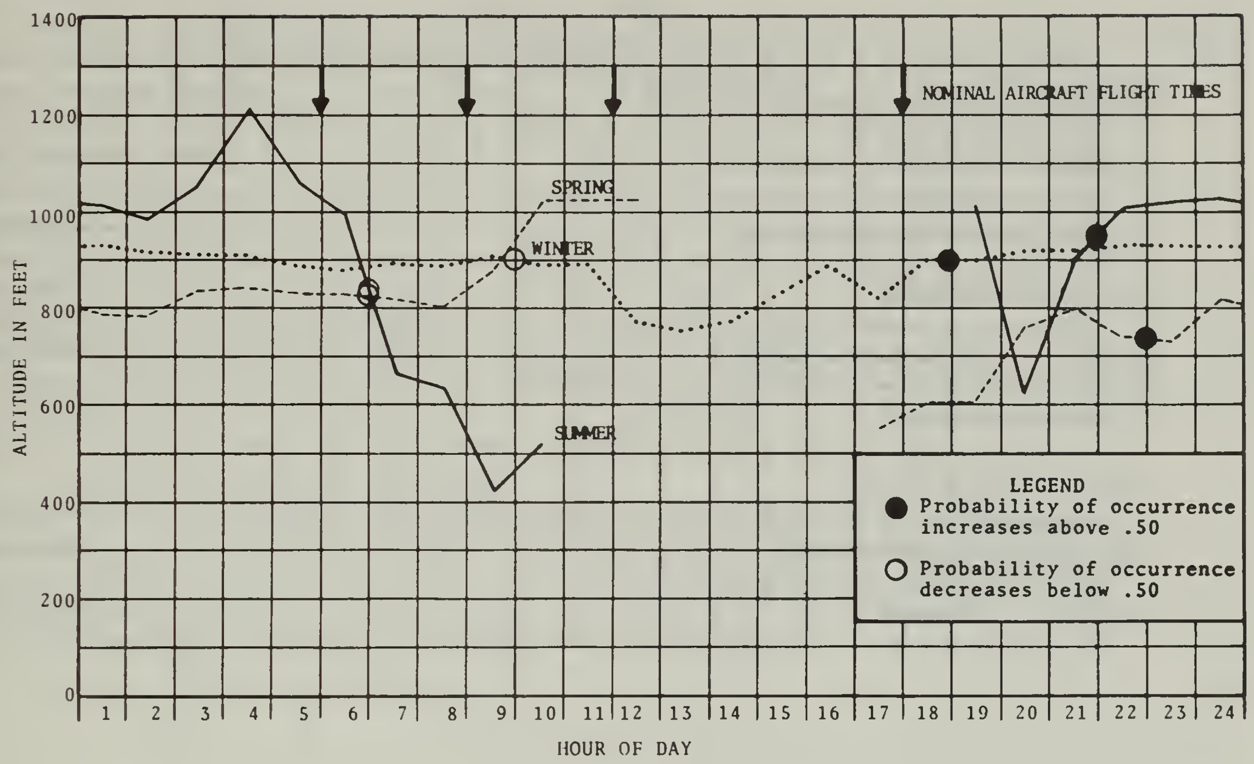


Figure II B-8

SUMMARY BY SEASON OF MEAN ALTITUDE

a



SUMMARY BY SEASON OF PROBABILITY OF INVERSION

b

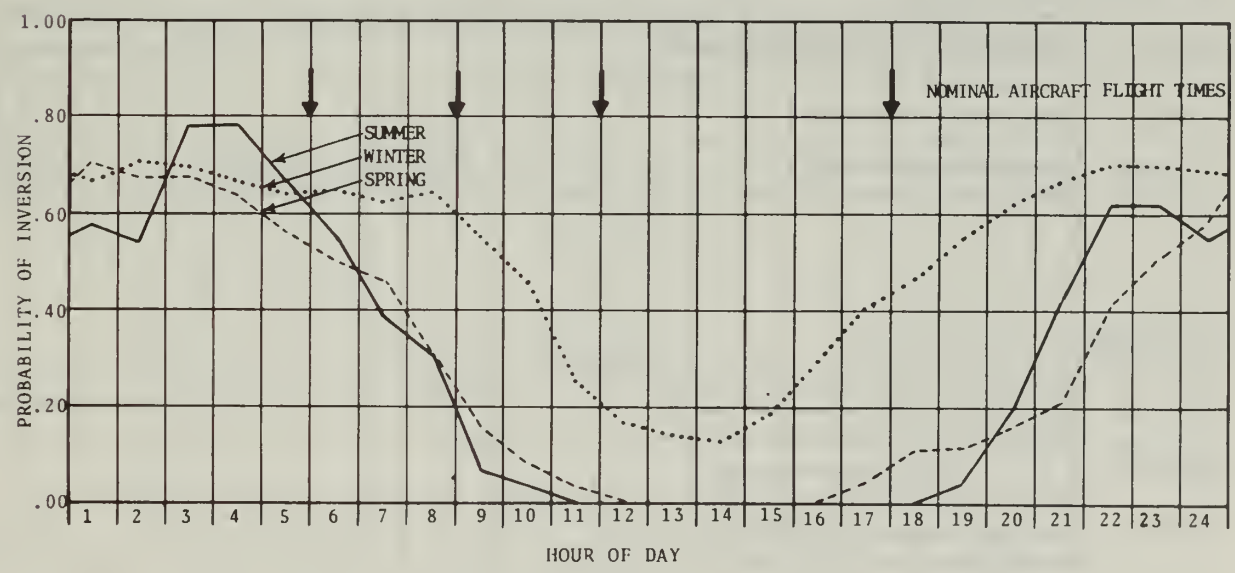
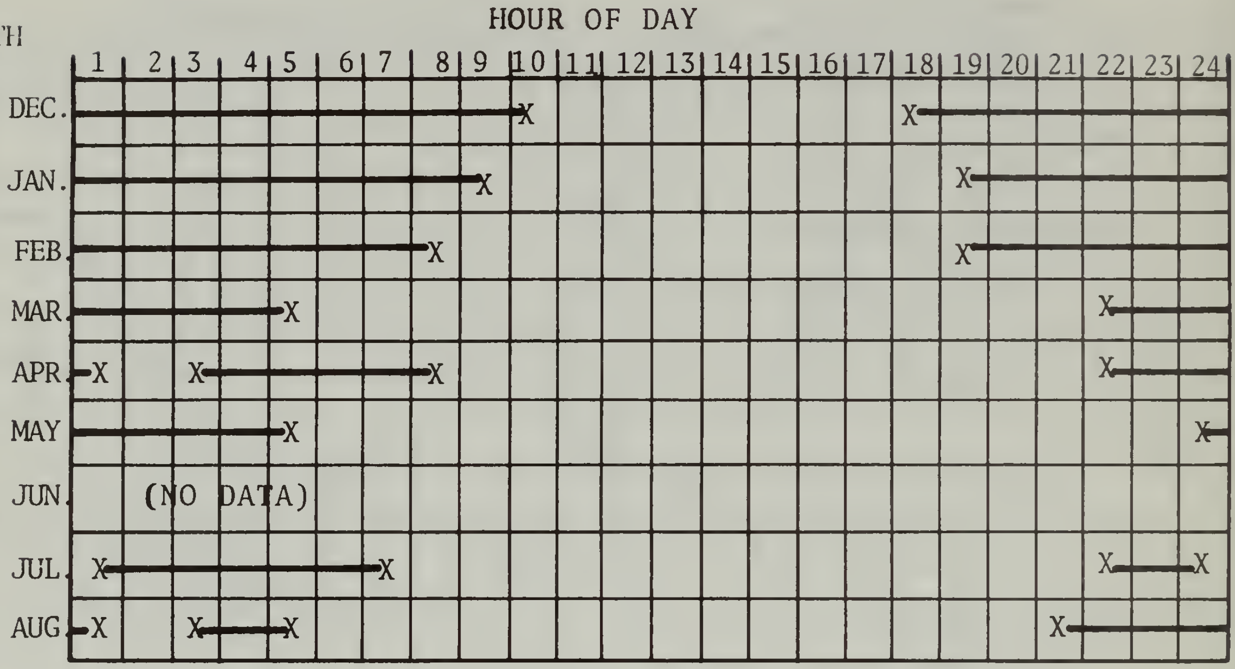


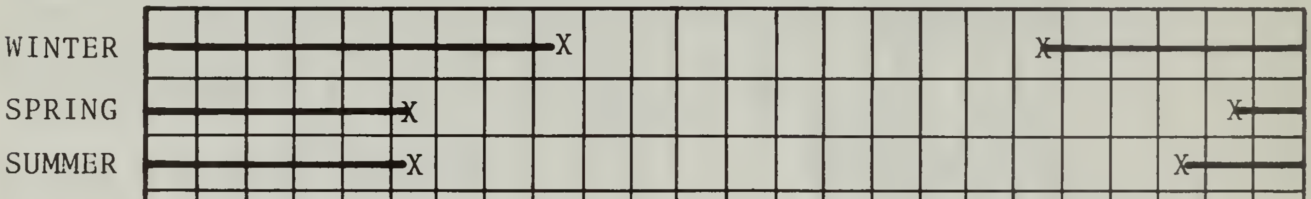
Figure II B- 9

CALCULATED PROBABILITY OF OCCURRENCE (p≥.5)

a) BY MONTH



b) BY COMPLETE QUARTER



c) BY AIRCRAFT FLIGHT DAYS

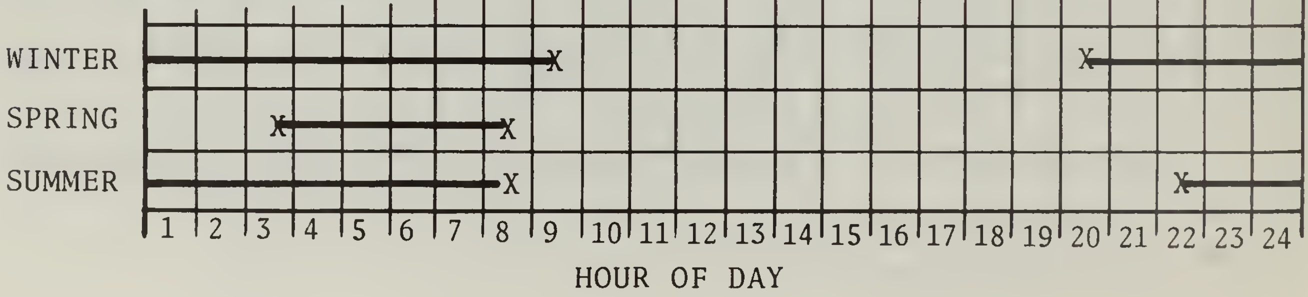
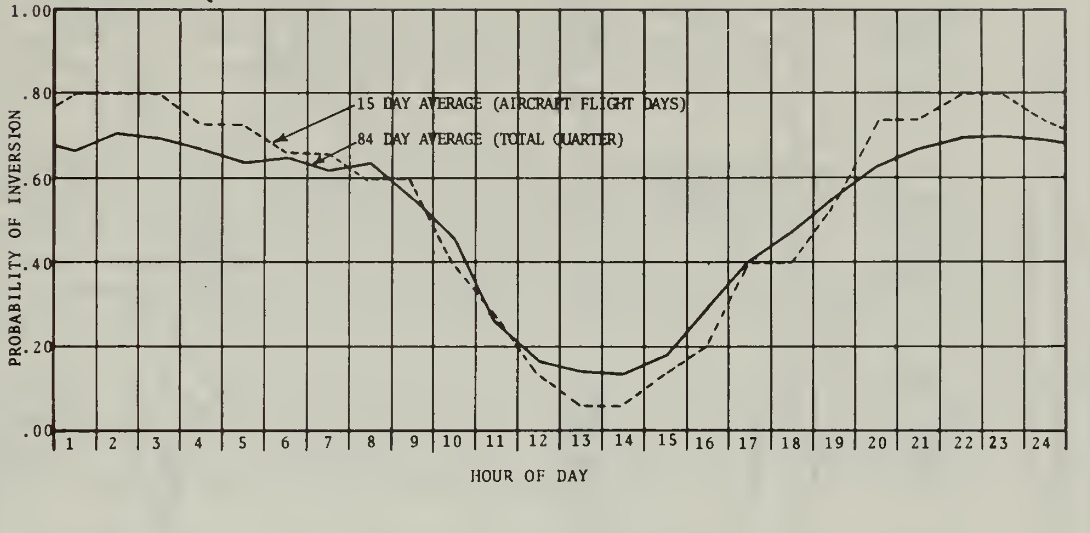


Figure II B-10

PROBABILITY OF INVERSION

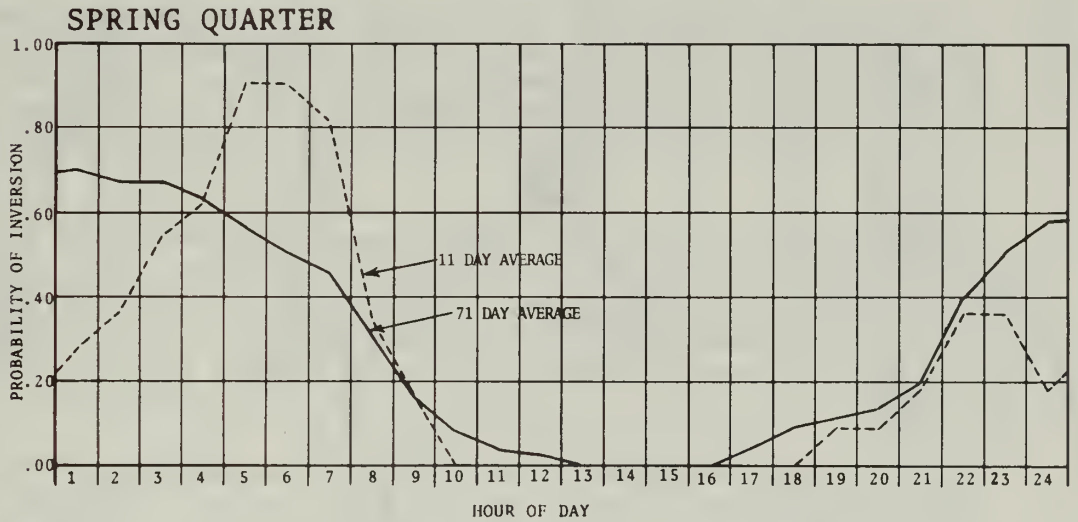
a

WINTER QUARTER



b

SPRING QUARTER



c

SUMMER QUARTER

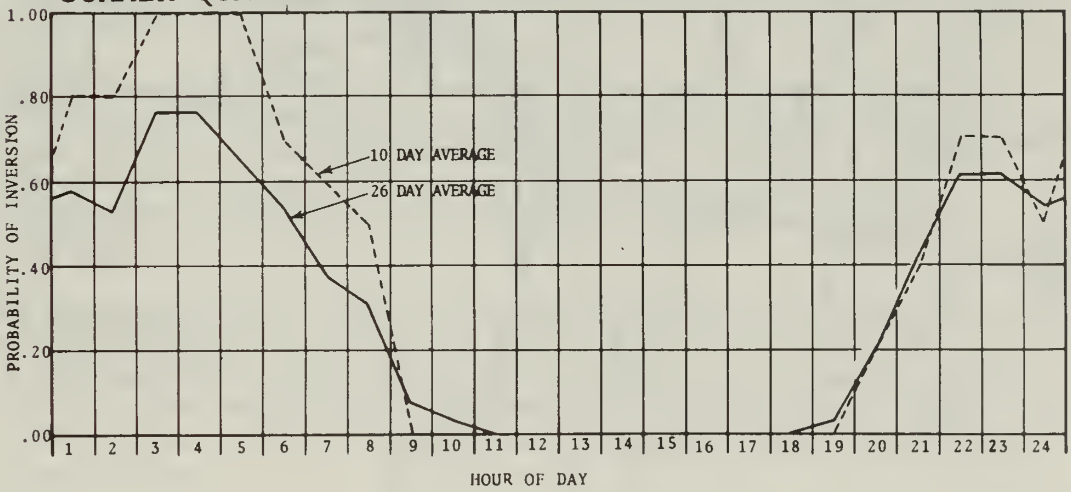
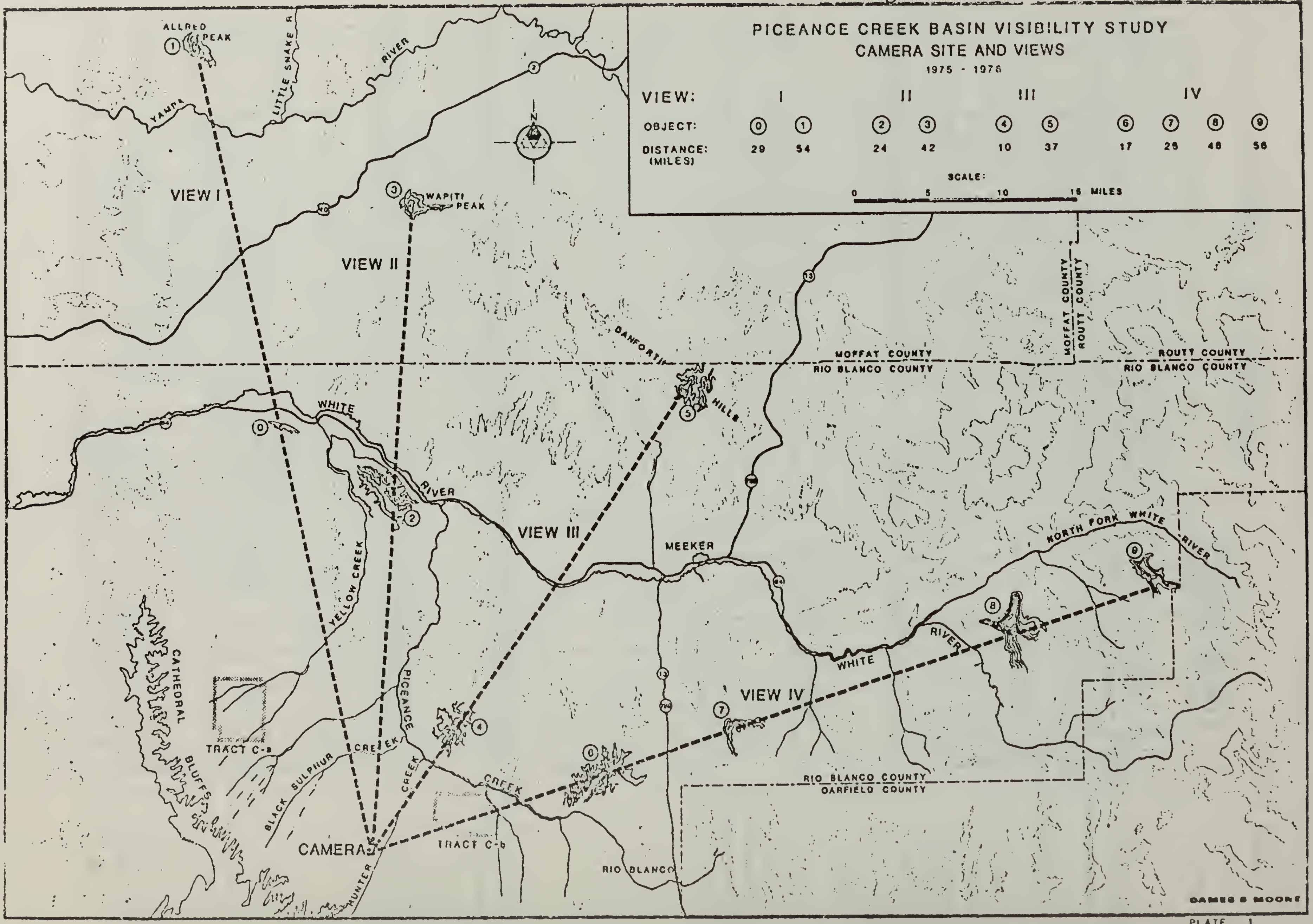


Figure II B-11



PICEANCE CREEK BASIN VISIBILITY STUDY
CAMERA SITE AND VIEWS
1975 - 1976

VIEW:	I	I	II	II	III	III	IV	IV	IV	IV
OBJECT:	⓪	①	②	③	④	⑤	⑥	⑦	⑧	⑨
DISTANCE: (MILES)	29	54	24	42	10	37	17	25	46	56

hours; all views were sufficiently clear for photography, however, by 1400 MST. On January 2, 1976, the Site Log reported haze in Views I and II in the morning and in all views by 1400 MST. During the fall monitoring period, Views I and II did not clear as early as Views III and IV. Haze or fog was also reported in the Site Log to be visible in all views on February 7, 1976.

Monthly mean visual-ranges obtained during the winter months varied from 72 miles in January to 86 miles in December; maximum values were between 140 to 150 miles; minimum values were below 30 miles. The general visual-range characteristics of each of the winter months are listed in Table II B-38. The median visual-ranges during the winter period were 82, 64, and 84 miles for December, January and February, respectively.

An average 13 percent per month increase in the monthly mean visual-range was indicated in the fall monitoring period. On the other hand a general decrease from the November high is observed in the winter monitoring period, with January showing the lowest mean.

During the Winter Quarter visual-ranges were generally high; 95 percent of the visual-range measurements were greater than 33 miles; 50 percent were greater than 81 miles. Pertinent statistics for each view and all views combined during the winter quarter are listed in Table II B-39. The winter composite mean shows a decrease of 12 percent from that reported in the fall data.

Maximum visual-ranges obtained during this period varied slightly among Views I, III, and IV; maximum values of 143, 149, and 147 miles were recorded for the respective views. The maximum visual-range in View II was 115 miles. Minimum visual-ranges varied among the views only slightly more than the maximum values. Minimum visual-ranges from 17 to 31 miles were recorded.

The mean visual-ranges of the four views during the winter quarter are comparable, with the exception of View II, which has had the lowest visual-range of the views, both during the fall and winter monitoring periods. The mean visual-ranges for Views I, III, and IV were 87, 83 and 86 miles respectively; the mean visual-range in View II, however, was 66 miles.

The mean visual-range exhibited in View II suggests a very localized condition affecting the visibility along the View II alignment. Definite conclusions, as to the explanation of this reduction in the mean visual-range, are impossible; because of a small sample set and the lack of additional supporting information only preliminary suppositions could be made at this time.

The generalized visibility used to describe the areal visibility in the Piceance Creek Basin area during the winter quarter was 80 miles. This value can be considered in comparison with the results of a similar study conducted over an eight-month period (September 74 - April 75) at Grand Valley, Colorado (Dames & Moore, 1975). The generalized visibility during this study was 86 miles.

Table II B-38

VISUAL RANGE (MILES) STATISTICS FOR ALL VIEWS COMBINED FOR EACH MONTH OF MONITORING PICEANCE CREEK BASIN, COLORADO 1975-1976

MONTH	MEAN	MAXIMUM	MINIMUM	STANDARD DEVIATION
September	77	131	42	24.0
October	89	144	44	24.6
November	99	149	24	29.0
December	86	147	17	31.1
January	72	137	27	29.2
February	84	149	25	28.2
March				
April				
May				
June				
July				
August				
September				

Table II B-39
VISUAL RANGE SUMMARY (MILES)
PICEANCE CREEK BASIN, COLORADO

FALL, 1975

VIEW	MEAN	MAXIMUM	MINIMUM	5 PERCENTILE	STANDARD DEVIATION
I	93	149	37	49	27.8
II	77	142	42	43	23.6
III	92	146	24	46	27.4
IV	101	148	48	52	25.8
Composite	91	149	24	45	27.3

WINTER, 1975-76

VIEW	MEAN	MAXIMUM	MINIMUM	5 PERCENTILE	STANDARD DEVIATION
I	87	143	31	41	23.9
II	66	115	31	41	19.2
III	83	149	17	30	34.1
IV	86	147	22	26	35.4
Composite	80	149	17	33	30.0

SPRING, 1976

SUMMER, 1976

A composite distribution of all visual-range measurements independent of direction during the winter quarter is illustrated in Figure II B-12. Visual-ranges obtained during this period occurred more frequently between 100 and 110 miles, although the frequency of occurrence varies little from 40 to 110 miles, suggesting the variability of the season.

Mean hourly visual-ranges for each view and for all views combined are presented in Figure II B-13 for each hour of photography.

In contrast to the fall data, hourly fluctuations in the winter's mean visual-ranges of Views I and II exhibit little similarity with the exception of the late afternoon decrease in the visual-range common to all views.

The mean hourly visual-ranges in Views III and IV exhibit very similar changes along the course of an average day. The visual-range in both views decreases during the early morning hours, increases slightly until early afternoon, and then decreases to the minimum mean visual-range for the day. Conversely, during the fall monitoring period all views experienced a morning peak in visual-range, a definite decrease after this peak, and a steady afternoon increase to the maximum visual-range at 1500 MST. The composite trend, shown in Figure II B-13 exhibits only slight variations during the day, whereas during the fall period, the composite followed the same trends common to all the views as described above.

At the present time, adequate data do not exist to attempt an explanation of the trends illustrated in Figure II B-13; additional data are required before any conclusions can be drawn.

II B-5 Noise

Monthly noise measurements are made at the 14 locations cited on Figure II C-7 of Quarterly Summary Report #4 utilizing a General Radio 1565-B sound-level meter. Data for this reporting period cover the months of December 1975 through February 1976 and are contained in Quarterly Data Report #6. Average values at A-weighting are about 65 db along Piceance Creek road in presence of passing vehicles and 45-50 db at the on-tract sites. Maxima of 83 db were achieved in December at the SG-11 site owing to presence of swabbing rig and in January along Piceance Creek road owing to a heavy road scraper passing by the site.

II B-6 Atmospheric Diffusion Studies

A nomograph of the Briggs plume rise formulae has been developed to facilitate rapid plume-rise calculations.

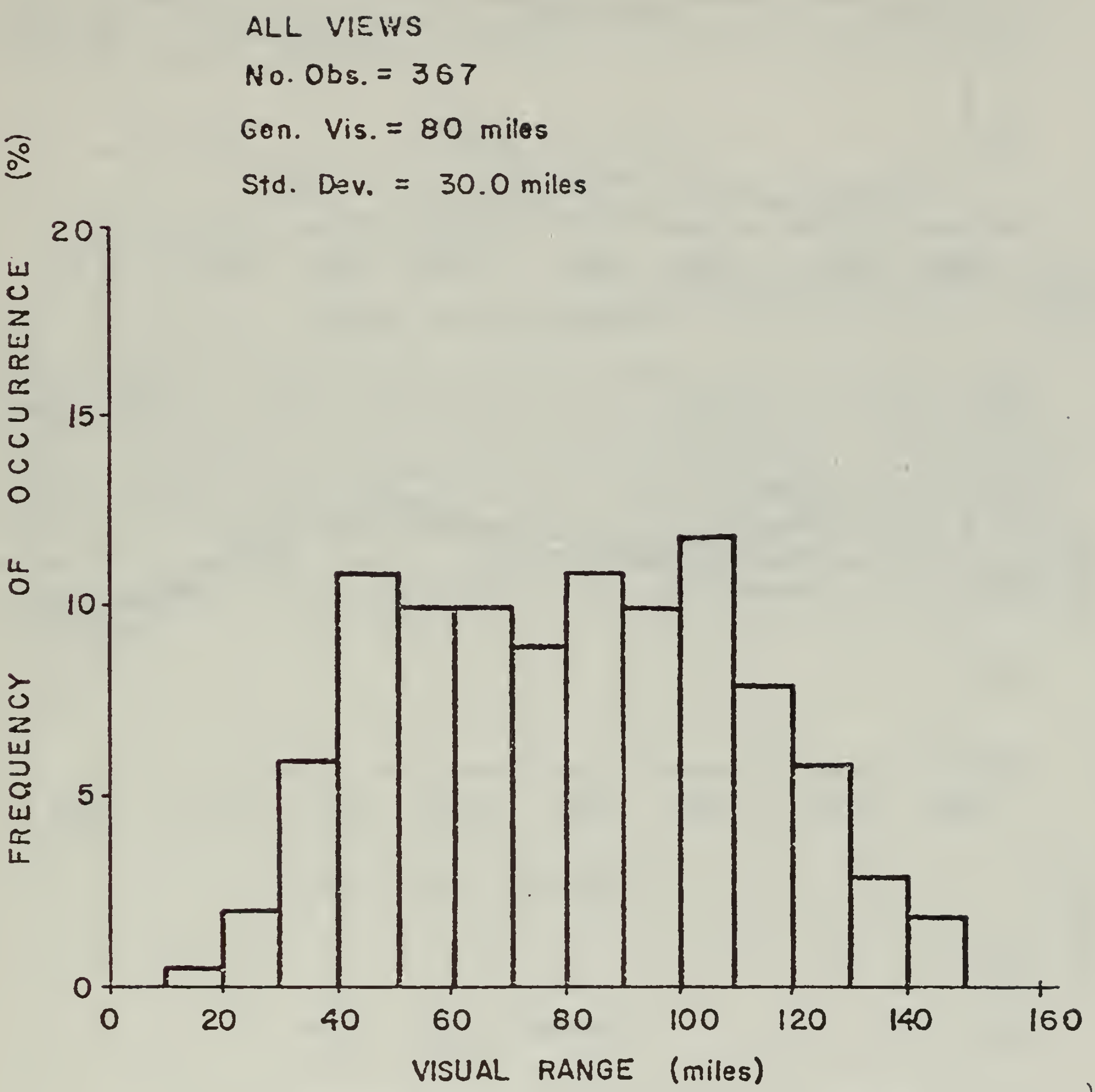


FIGURE II B-12

COMPOSITE VISUAL RANGE DISTRIBUTION
PICEANCE CREEK BASIN, COLORADO

WINTER, 1975-76

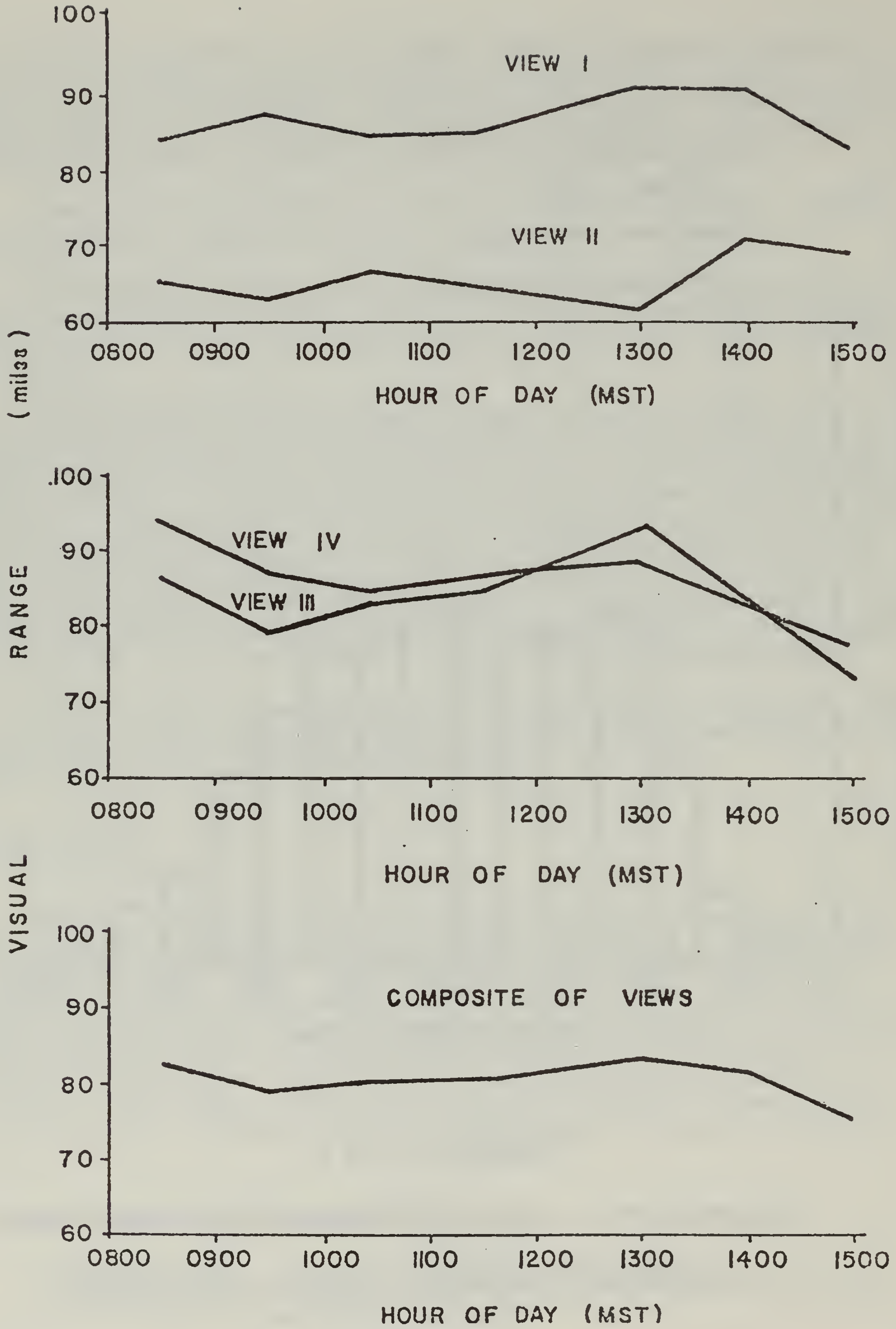


FIGURE II B-13

VARIATION IN THE MEAN HOURLY VISUAL RANGE PICEANCE CREEK BASIN, COLORADO WINTER, 1975-76

Even though Gaussian plume models do not apply very well in rough terrain such as encountered at the C-b Tract some preliminary insights are provided through their use. Such models refer to a critical wind speed as that which results in a maximum ground level concentration of the plume. Further, critical wind speed (V_{crit}) has been derived in terms of stack height (h_s) as

$$V_{crit} = \frac{K_c}{h_s} \quad *$$

where $K_c = \Delta H_{max} V$ = constant

= Product of maximum plume rise (ΔH_{max}) and associated given velocity (V)

Thus at critical wind speed the maximum plume rise is equal to the stack height so that the effective stack height is twice the stack height. Utilizing this fact and the nomograph, Figure II B-14 presents critical wind speed as a function of ambient temperature for the elutriator, preheater, H_2 furnace, sulfur plant, and shale wetter along with their effective stack height. Design parameters for these stacks appear in a previous summary report. These effective stack heights are probably those at which atmospheric stability determinations are most significant.

---

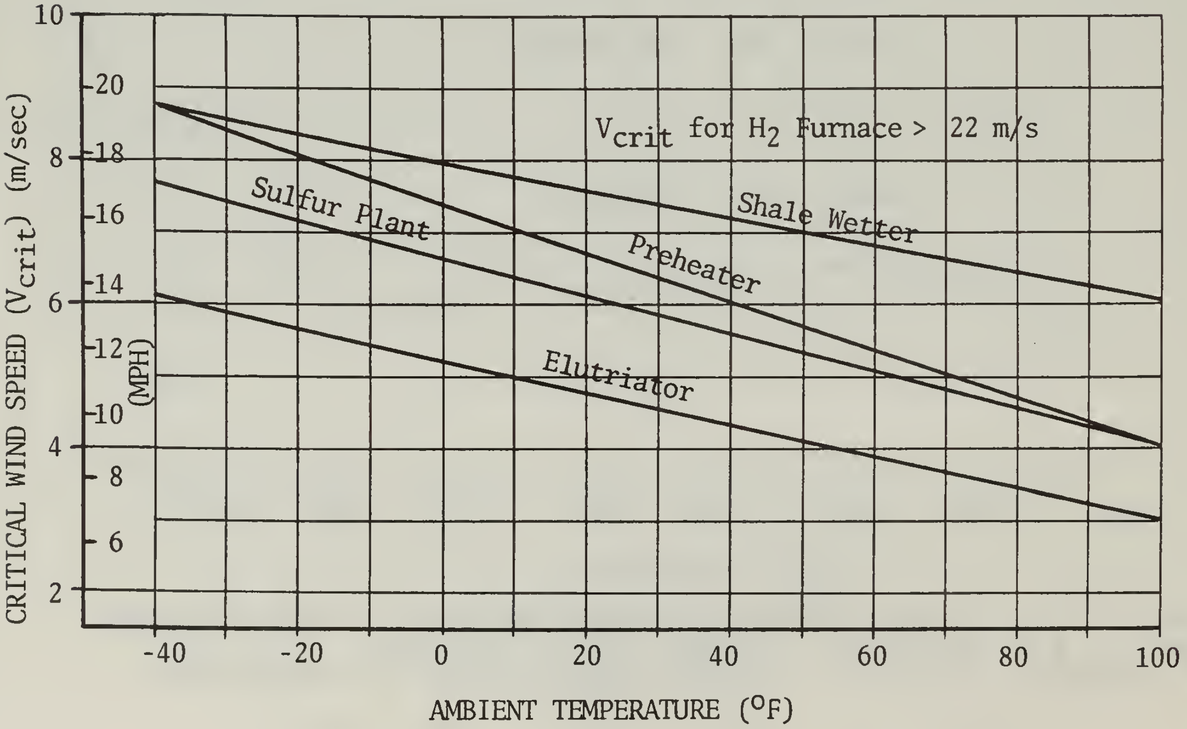
*Wanta, R. C. (1968); Meteorology and Air Pollution, in Air Pollution, Vol. I, A. C. Stern (ed.), Academic Press, New York

Figure II B-14

CRITICAL WIND SPEED FOR MAX. GROUND CONCENTRATION OF PLUME AND CORRESPONDING PLUME RISE

Modified Briggs Plume Rise Eq.

STACK	PLUME RISE @ V_{crit}		EFF. STACK HEIGHT	
	(m)	(ft)	(m)	(ft)
Preheater	95	311	190	623
Elutriator	95	311	190	623
H_2 Furnace	25	82	50	164
Sulfur Plant	65	213	130	426
Shale Wetter	95	311	190	623



II C BIOLOGY

The biological studies in this quarter are discussed in the following sections:

II C-1 Terrestrial Wildlife Studies
Big Game; Medium-sized Mammals: Small Mammals and Avifauna
II C-2 Aquatic Studies
Fish; Benthos; Periphyton; Plankton; Primary Productivity; Water Quality; Sediment Analysis; Springs and Seeps; and Other Studies
II C-3 Terrestrial Vegetation Studies
II C-4 Soil Survey

II C-1 Terrestrial Wildlife Studies

Big Game

During this quarter the following tasks were performed; 1) deer road counts, 2) observations of deer distributions and movement patterns, 3) a determination of the late winter fawn-doe ratio, and 4) a bimonthly count of deer and medium-sized mammal tracks (track count).

Counts of deer along roads, conducted during this quarter, indicate diurnal and seasonal patterns of deer movement similar to those observed during the same period in 1974-75 (Table II C-1). In December, the pinyon-juniper woodlands, chained areas, and upland sagebrush habitat types were utilized more heavily by deer than the agricultural meadows which were seldom utilized. In January and early February an increase in the usage of the south-facing slopes and haystacks occurred as the food supply dwindled elsewhere.

Ninety-six of the 99 deer which could be carefully observed at close distance appeared to be in good condition.

Even though the adults appeared to maintain a good condition through the winter, a significant number of fawns died. The fawn-doe ratio dropped from 113:100 in November to 69:100 on February 28.

Medium-sized Mammals

The track count conducted this quarter revealed that coyotes, cottontails and mule deer were encountered more often in the pinyon-juniper woodland than in the other habitats (Table II C-2). The high incidence of coyote tracks may be in response to the abundance of deer and cottontails, which are major prey species. An uncommonly observed species, the long-tailed weasel, was identified in the chained, pinyon-juniper habitat.

Table II C-1 MULE DEER ROAD COUNTS CONDUCTED DECEMBER 1975 AND JANUARY AND FEBRUARY 1976

Mile Interval	Location	Number of Deer Observed																			
		December						January								February					TOTALS
		9	12	18	19	22		6	9	13	19	23	24	28		4	11	24	26		
1	Little Hills																	1			1
2									3				8					3	2		16
3												1					2	35	17		55
4									5	6		3					9	22	12		57
5												17						30	8		55
6												1						9	13		23
7											21	21		8			11	31	9		101
8								3										9			12
9	Ryan Gulch											12					3	23	10		48
10				4				5	4			14	4	19		10	10	30	30		130
11								2	10	8	7	11	8	2		7	6	10			71
12	Black Sulphur Creek							2	6	2	2	9	1					5	15		42
13				1						4	4		1	1		6	4	13	1		35
14	Hunter Creek	9		4						1				5							19
15												4									4
16	{Willow Creek			4	4							2	3					6	14		33
17	Tract C-b {							1		2	7	7	5			3	3		4		32
18	{Sorghum Gulch					3		5	6	5	3	4	4				2	2			42
19	{																				0
20	{Stewart Creek				1								3								4
21																		7			7
22												2									2
23								5				4		11				19	38		77
24																	32	39	2		73
25	Story Gulch					5												7	10		22
26					10	2				3							3		4		22
27																					0
28						11												4			15
29																	3	4	5		12
30					4			8				3							3		13
31												9									9
32										1											1
33					3																3
34												3									3
35																					0
36	Rio Blanco																				0
	TOTALS	9	0	13	18	25		31	34	32	44	127	37	46		26	88	309	202		

Table II C-2 PERCENT FREQUENCY* OF TRACKS FROM COUNTS CONDUCTED ON JANUARY 25, 1976

Habitat Type	No. of Quadrats	Deer	Coyote	Cottontail	Other
Pinyon-juniper woodland	100	2	12	7	0
Chained pinyon-juniper	100	2	1	2	1**
Valley sagebrush	100	0	8	0	0
Lower valleys and agricultural meadows	100	2	1	0	0

---

* Percent Frequency = Number of quadrats with tracks/total number of quadrats x 100

** Long-tailed weasel, *Mustela frenata*

Small Mammals

Traps were set at some of the satellite grids and near some of the haystacks in the meadows to assess the relative abundance and activity of small mammals during the winter. The deer mouse was the most abundant small mammal during the winter months; voles were second most abundant. Neither of these species hibernate. The least chipmunk, Colorado chipmunk, and the bush-tailed woodrat, which are common during other times of the year, were apparently inactive during the winter sampling period (Table II C-3).

Home ranges were calculated for the least chipmunk and the deer mouse from previous observations of the trapping grids at Sites 1 and 2 (Table II C-4). The mean home-range size for the least chipmunk varied from 0.97 hectares (ha) for females to 1.40 ha for males in the pinyon-juniper woodland and 0.95 ha for females to 1.17 ha for males in the chained rangeland. For the deer mouse the mean home-range size was somewhat smaller and varied from 0.61 ha for males to 1.19 ha for subadult females in the pinyon-juniper woodland and from 0.65 ha for females to 0.67 for adult males in the chained rangeland.

Avifauna

Songbirds, waterfowl, and raptorial birds were censused during February 1976. Transect locations are shown in Figure II C-1 and the transect descriptions are presented in Table II C-5. The most common songbird species on the Tract C-b area during this quarter were the Bohemian waxwing, pinyon jay, house finch, red crossbill, evening grosbeak, and horned lark (Table II C-6). Only two habitats, the pinyon-juniper woodland (Transects 4 & 5) and the valley sagebrush (Transect 6), supported high densities of wintering birds at the time the censuses were made. Diversity was highest in the upland transition habitat (Transect #7), where distribution of individuals among seven species accounted for high diversity. on the other hand, species diversity in the pinyon-juniper woodland along Transect 5 was unexpectedly low as a result of a very high density (91%) of Bohemian waxwings.

Qualitative survey values (Table II C-7) were influenced by tendencies of many wintering species to form flocks which drift from habitat to habitat. However, results of the qualitative survey complemented the results of the quantitative strip transects; the majority of species was encountered in the pinyon-juniper woodland. Common flocking species, which showed high relative abundance, included the horned lark (44.2 percent), house finch (11.6 percent), red crossbill (11.6 percent), and evening grosbeak (7.0 percent). Species which did not form large flocks, but were encountered throughout the study area, included the golden eagle and common raven. Overall numbers of birds tallied during the February-1976 qualitative counts were lower than numbers found during the winter-1975 sampling periods but this is attributed to differences in sampling intensity. Fewer qualitative surveys were conducted during the eight censuses because of inclement weather; sampling was increased along quantitative transect routes.

Table II C-3 SATELLITE GRIDS TRAPPING DATA FOR JANUARY AND MARCH 1976

SPECIES		JANUARY 1976								FEBRUARY 1976					
		Satellites*				Satellites*				Willow Creek Haystack		Tract Entrance Haystack		Tract Entrance Piceance Creek	
		#1		#8		#1		#8							
		48 Trap Nights		48 Trap Nights		72 Trap Nights		60 Trap Nights		16 Trap Nights		12 Trap Nights		12 Trap Nights	
Scientific Name	Common Name	Total Capture	% of Total	Total Capture	% of Total	Total Capture	% of Total	Total Capture	% of Total	Total Capture	% of Total	Total Capture	% of Total	Total Capture	% of Total
Insectivora															
Sorex sp.	Shrew	1	2%			1	1%								
Rodentia															
Microtus montanus	Montane vole	1	2%	1	2%										
Microtus sp.	Vole			5	10%	4	5%								
Peromyscus maniculatus	Deer mouse							5	8%	1	6%	0	-	1	8%
TOTAL		2	4%	6	12%	5	6%	5	8%	1	6%	0	-	1	8%

---

* Location	Habitat Type
#1 - Piceance Creek	Riparian/Willow - Alfalfa
#2 - Willow Creek	Pond/Sagebrush - Alfalfa

Table II C-4 SIGMA AND HOME RANGE* VALUES FOR LEAST CHIPMUNKS AND DEER MICE ON A CHAINED PINYON-JUNIPER SITE AND A PINYON-JUNIPER WOODLAND

Site/Species	Number of Individuals	Total Captures	Sigma (m)	Home Range (ha)	Range of S_i
CHAINED PINYON-JUNIPER					
Eutamias minimus					
Males	14	93	30.6	1.17	17.0-47.7
Females	11	106	27.5	0.95	18.4-40.0
Peromyscus maniculatus					
Adult Males	4	24	23.0	0.67	21.6-25.8
Subadult Males	3	22	19.8	0.49	15.2.-22.7
Females	12	101	22.8	0.65	10.0-31.1
PINYON-JUNIPER WOODLAND					
Eutamias minimus					
Males	3	16	33.3	1.40	25.1-37.8
Females	7	58	27.8	0.97	15.2-36.8
Peromyscus maniculatus					
Females	11	88	21.9	0.61	10.6-29.9
Adult Males	7	61	23.6	0.70	17.6-28.5
Subadult Females	2	15	30.7	1.19	26.4-38.7

*Home range is defined as the area in which the animal spends 86 percent of its time and is calculated by the method of Calhoun & Casby (1958).

$$\text{Home Range} = \Pi(2\sigma)^2$$

$$\sigma = \left[\frac{\sum_{i=1}^{n} \sum_{j=1}^{k_i} \left\{(\bar{x}-x_{ij})^2+(\bar{y}_i-y_{ij})^2\right\}}{2(\sum_{i=1}^{n} k_i-n)} \right]^{\frac{1}{2}}$$

Where sigma, σ, represents the radius of a circle within which the probability of the animal being present is 39 percent if its movements can be described by a bivariate normal density function.

k_i = number of captures of i^{th} animal
n = number of animals
x_{ij} & y_{ij} = position of i^{th} animal on j^{th} capture

$$\bar{x}_i = \frac{1}{k_i} \sum_{j=1}^{k_i} x_{ij} , \quad \bar{y}_i = \frac{1}{k_i} \sum_{j=1}^{k_i} y_{ij}$$

S_i is the estimate of σ for each individual animal

$$S_i = \left[\frac{\sum_{j=1}^{k_i} (\bar{x}_i-x_{ij})^2+ (\bar{y}_i-y_{ij})^2}{2(k_i-1)} \right]^{\frac{1}{2}}$$

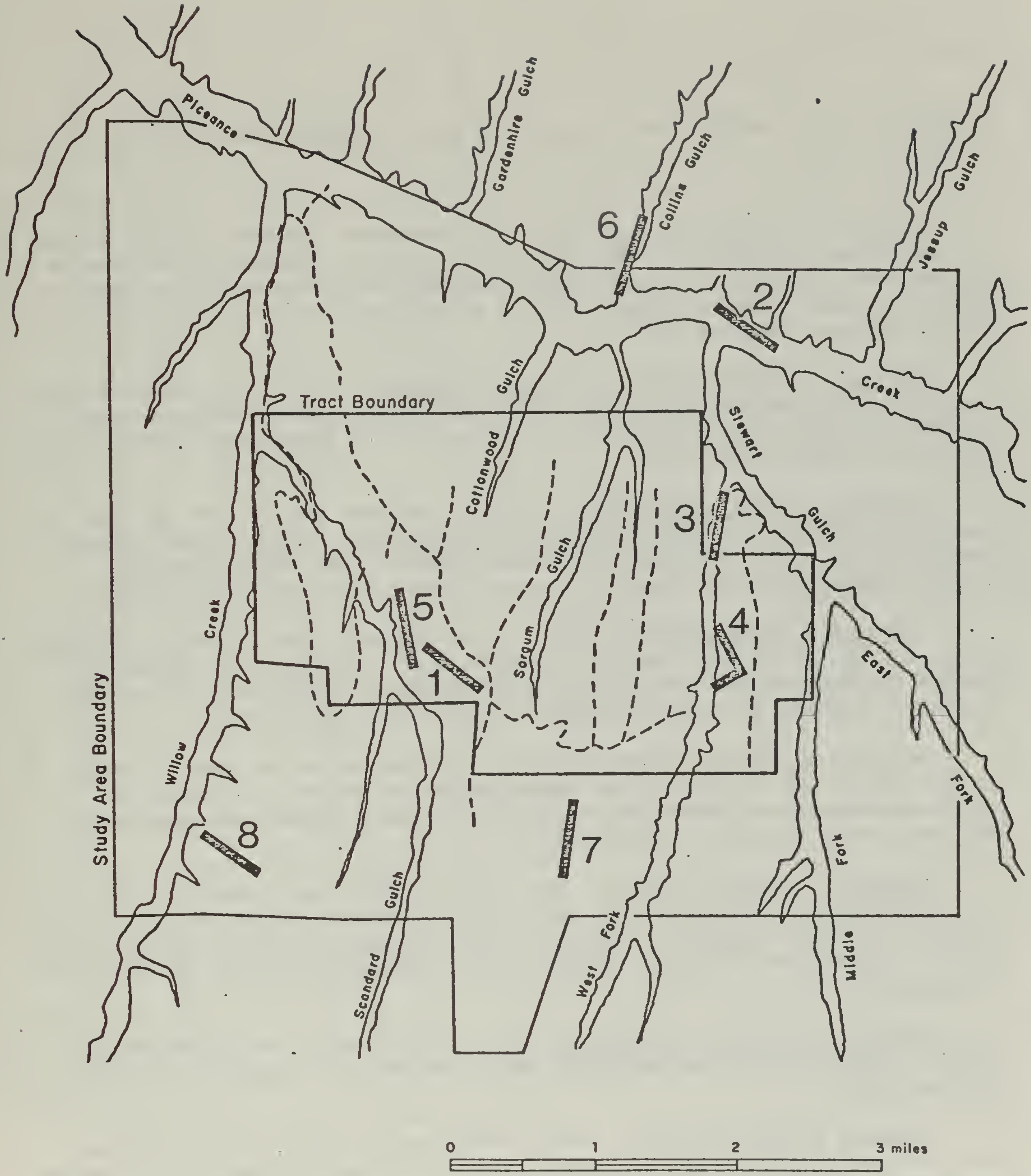


Figure II C-1 AVIFAUNA STRIP TRANSECT LOCATIONS, TRACT C-b STUDY AREA

Table II C-5 DESCRIPTION OF THE EIGHT STRIP TRANSECTS ON TRACT C-b

---

Transect 1 (Mammal Plot No. 1). This transect includes chained pinyon-juniper rangeland habitat. The vegetation includes a heterogeneous mixture of immature pinyon pine, serviceberry, Gambel's oak, sagebrush, and bitterbrush. A large number of snags provide specialized habitats for certain birds (transect bearing 140°).

Transect 2 (Oldland Ranch - Piceance Creek). Bordered by grazed pasture, this transect traverses along Piceance Creek west to east. Several small stands of Douglas fir and mountain shrub border the south-east corner of the plot (transect bearing 120°).

Transect 3 (West Fork Stewart Gulch). Bordered to the east and west by sharply rising slopes, this north-south transect traverses through a dense, heterogeneous stand of sagebrush and rabbitbrush. The eroded sandstone slopes support a sparse growth of pinyon-juniper (transect bearing 12°).

Transect 4 (Mammal Plot No. 2). This transect route through a pinyon-juniper woodland includes only one habitat type. The trees are primarily mature pinyon pine and juniper with a sparse understory of mountain shrub (transect bearing 65° for 300 meters, and 340° for 500 meters).

Transect 5 (Pinyon-juniper Woodland). Bordered to the east by large tracts of chained pinyon-juniper rangeland, this transect traverses an undisturbed stand of mature pinyon-juniper having a sparse understory of mountain shrub (transect bearing 190°).

Transect 6 (Collins Gulch). The strip transect runs south to north on the west slope of Collins Gulch; this strip is bordered on the west by sandstone banks which maintain a sparse covering of pinyon-juniper and mountain shrub. A north-south highway forms the east boundary of the strip (transect bearing 15°).

Transect 7 (Upland Transition). This strip transect traverses through upland sagebrush interspersed with immature pinyons and junipers (transect bearing 200°).

Transect 8 (Willow Creek). This steep, north facing slope traverses east to west through a mountain shrub habitat. A sparse overstory of pinyon pine and juniper is scattered throughout the transect, while a dense mixture of serviceberry, Gambel's oak, sagebrush, and snowberry compose the understory (transect bearing 310°).

TRANSECT*/	1		2		3		4		5		6		7		8		
	#	#/ha	#	#/ha	#	#/ha	#	#/ha	#	#/ha	#	#/ha	#	#/ha	#	#/ha	Total
Horned Lark	2	0.3															2
Common Raven	3	0.1					1	0.1					4	0.2			8
Townsend's Solitaire	2	0.1					2	0.1	5	0.5	1	0.1					10
Red Crossbill	4	0.3					31	2.0	6	0.2	11	1.4	4	0.2	2	0.2	58
Rufous-sided Towhee	1	0.2															1
Red-winged Blackbird			1	0.1													1
House Finch			1	0.1	3	0.1	89	4.0			18	1.8	8	0.4	3	0.3	122
Song Sparrow			5	0.3													5
Scrub Jay					1	0.1	2	0.1	1	0.1	2	0.2	2	0.1			8
Evening Grosbeak					1	0.1	25	0.6			1	0.1	8	0.4			35
Common Flicker							1	0.1									1
Downy Woodpecker							2	0.1									2
Black-capped Chickadee							4	0.1									4
Mountain Chickadee							8	1.1	13	1.0			3	0.2			11
White-breasted Nuthatch							9	0.5	8	0.2							17
Red-breasted Nuthatch							7	0.4									7
Robin							1	0.1	3	0.1							4
Bohemian Waxwing							15	0.3	193	28.7	75	7.7			10	1.0	293
Pinyon Jay									45	0.8							45
Black-billed Magpie									7	0.1	1	0.1	1	0.1			9
Clark's Nutcracker									2	0.1							2

TABLE II C-6

Results of Strip Transect Censuses of Birds at 8 Transects During February 1976

*See Figure II C-1 for Transect Location

TABLE II C-7 RESULTS OF QUALITATIVE COUNT SURVEYS AT TRACT C-b CONDUCTED FEBRUARY 8-12, 1976

Species	Number Tallied	% Relative Abundance*
Golden eagle	3	3.5
Bald eagle	2	2.3
Common flicker	1	1.2
Downy woodpecker	1	1.2
Horned lark	38	44.2
Scrub jay	2	2.3
Black-billed magpie	1	1.2
Common raven	4	4.6
Mountain chickadee	3	3.5
Loggerhead shrike	1	1.2
Red-winged blackbird	2	2.3
Evening grosbeak	6	7.0
House finch	10	11.6
Red crossbill	10	11.6
Unidentified species	2	2.3
TOTALS	86	100.0

*Percent Relative Abundance was calculated as:

$$\%\ \text{Relative Abundance} = \frac{\text{Number of individuals of species A}}{\Sigma\ \text{Number of individuals of all species}} \times 100$$

Winter censuses at two observation ponds demonstrated a relatively heavy usage of the P-L ranch pond by the American wigeon, blue-winged teal, common goldeneye, green-winged teal, and the mallard. Usage of the W. Oldland ranch pond was relatively light with only a few American wigeon and common goldeneye observed. Low usages of this pond compared to the P-L ranch pond is attributed to fluctuating depth of the Oldland ranch pond, the nature of the shoreline vegetation, and proximity to the Steward Gulch road.

Nine raptor species were observed in the tract vicinity during February. The golden eagle, bald eagle, rough-legged hawk, and the red-tailed hawk represented the falconiformes species encountered (Table II C-8). The great horned owl, long-eared owl, screech owl, and short-eared owl comprised the strigiformes noted. Golden eagles were observed throughout the study area. On several occasions both golden and bald eagles were observed feeding on deer carcasses. Four individual bald eagles (three adults and one immature) were estimated to be wintering in the C-b tract vicinity. The bald eagle is a winter resident of the Piceance Basin as is the rough-legged hawk. Only three rough-legged hawks were estimated to be residents this winter.

Great horned owls were common and were recorded in all habitat types. One screech owl, one long-eared owl, and one short-eared owl were observed during December 20 and 21, 1975. Short-eared owls are uncommon winter visitors to open fields in western Colorado, marshlands and grassy fields being the preferred habitats.

During the reporting quarter, four species of birds not previously observed within the vicinity of Tract C-b were observed. These are the short-eared owl, Bohemian waxwing, evening grosbeak, and red crossbill. These bring to 129 the number of bird species known to utilize habitats on Tract C-b. No rare, threatened, or endangered bird species, as defined by the U. S. Department of the Interior, were observed in the study area during the winter censuses.

The species composition of the avian communities encountered during February 1976 differed from that of the January 1975 censuses. The abundant species of the most recent censuses, evening grosbeaks, red cross-bills, Bohemian waxwings and house finches were not recorded at all during the previous winter. These species tend to appear sporadically, but in large numbers, during winter in certain portions of the nation. It is clear that the pinyon-juniper habitat within the Piceance Basin is occasionally "invaded" by large concentrations of these birds. The absence of species which were common during the January 1975 sampling period (e.g., dark-eyed juncos, gray-headed juncos, tree sparrows) also demonstrates a marked difference in avian community composition from winter to winter. Significant changes in the composition of a wintering population in a seasonal environment are sometimes associated with periods of prolonged snow cover and low ambient temperature. The snow condition and temperature have varied during the past two winter seasons and this probably has contributed in part to differences in wintering avian communities.

Table II C-8 DIURNAL RAPTORS NOTED ON OR CLOSE TO TRACT C-b DURING THE WINTER, 1975-1976 SAMPLING PERIOD

Species		Total Individuals Observed*	% Relative Abundance
Golden eagle		4	3.9
Bald eagle		4	3.9
Rough-legged hawk		3	2.9
Red-tailed hawk		1	1.0
Raven***		91**	88.4
	TOTAL	103	100.0

*This is the estimated number of individuals of each species thought to have been on the tract during the winter sampling period. These numbers are based on distinct characteristics of individuals, areas of observation, available literature on winter territories of raptors, and observations of more than one individual of a species at a time. These are conservative estimates and probably underestimate the numbers of raptors actually using the area.

**This is the size of the largest flock of ravens observed in the study area during the December and February field periods.

***Ravens are included here because they are similar to raptors in their ecological roles (Craighead & Craighead 1969).

II C-2 Aquatic Studies

The aquatic studies for this quarter included bimonthly collections of fish, benthos, periphyton, water samples, and algae. Winter conditions were unfavorable for sampling at some of the stations. Piceance Creek had ice forming along the edges at many stations. Station P-7 was frozen over and some stations had turbid conditions. The White River was frozen over and could not be sampled in January. Stations P-0, W-1 and Upper Stewart Lake were also frozen over.

Fish

No new fish species were collected during this quarter. The mountain sucker, brook trout, and speckled dace were collected in Piceance and Stewart Creeks (Table II C-9). Brook trout were also captured in Lower Stewart Lake. Two previously tagged brook trout and one mountain sucker were recaptured.

Examinations of average lengths and weights for brook trout indicate a growth rate of approximately 120 mm in length and 60 gm in weight per year. The annual growth for mountain suckers was estimated at 24 mm in length and 18 gm in weight. Mean length and weight of fish captured in January compared with those found in previous months. The only exception to this was the lack of some of the large spawning brook trout that were taken in the fall. Population estimates could not be made during January because of the low numbers of fish captured at most stations.

Benthos

Benthic invertebrates were represented in January by three phyla: Annelida, Arthropoda, and Mollusca (Table II C-10). The arthropods, especially dipterans and ephemeropterans, were the most abundant. The mean biomass varied from 0.0656 gm/m^2 to 11.945 gm/m^2. Species diversity values ranged from 0.545 at Station P-2 to 3.317 at Station P-5.

Periphyton

Diatoms were the most numerous periphyton species collected during January. Green algae and blue-green algae were also collected. Periphyton primary productivity was greatest in Piceance Creek in January at Station P-3 and lowest at the downstream station (P-6). The highest productivity in January was found in Lower Stewart Lake and Upper Willow Lake (Table II C-11).

Plankton Primary Productivity

Phytoplankton primary productivity was measured in January using the light and dark bottle method in Upper and Lower Willow Lakes. Upper Stewart Lake was frozen over. Differences between dissolved oxygen

Table II C-9 NUMERICAL ABUNDANCE OF SPECIES OF FISH CAPTURED DURING JANUARY 1976 FROM PICEANCE AND STEWART CREEKS

Station	Species			Total
	Brook trout	Speckled dace	Mountain sucker	
P-1	-	-	1	1
P-2	1	2	65	68
P-3	1	1	2	4
S-2	15	5	7	27
LSL	12	-	-	12
Totals	29	8	75	112

Station Legend:

P1-3:	Piceance Creek
S-2:	Stewart Creek
LSL:	Lower Stewart Lake

Species Legend:

Brook trout - *Salvelinus fontinalis*

Speckled dace - *Rhinichthys osculus*

Mountain sucker - *Catostomus platyrhynchus*

Table II C-10 BENTHIC INVERTEBRATES COLLECTED ON TRACT C-b DURING JANUARY 1976

Scientific Name	Common Name
ANNELIDA	
Oligochaeta	Aquatic earthworms
Hirudinea	Leeches
ARTHROPODA	
Insecta	
Ephemeroptera	Mayflies
Baetidae	Small mayflies
Baetis	
Callibaetis c.f.	
Ephemerella	
Tricorythodes	
Odonata	Dragonflies and damselflies
Coenagrionidae	Narrow-winged damselflies
Ishnura	
Plecoptera	Stoneflies
Perlodidae	Perlodid stoneflies
Isoperla	
Coleoptera	Beetles
Haliplidae	Crawling water beetles
Brychius	
Dytiscidae	Predaceous diving beetles
Agabus	
Elmidae	Riffle beetles
Heterlimnius	
Optioservus	
Curculionidae	Snout beetles
Hyperoides	
Trichoptera	Caddisflies
Hydroptilidae	Micro-caddisflies
Hydroptila	

Table II C-10 (continued)

Scientific Name	Common Name
Hydropsychidae	Net-spinning caddisflies
Hydropsyche	
Brachycentridae	Brachycentrid caddisflies
Brachycentrus *Micrasema*	
Diptera	True flies
Tipulidae	Crane flies
Erioptera *Hexatoma* *Pedicia* c.f. *Tipula*	
Psychodidae	Moth flies
Psychoda	
Ceratopogonidae	Biting midges
Chironomidae	Midges
Simulidae	Black flies
Stratiomyiidae	Soldier flies
Eupharyphus	
Anthomyiidae	Anthomyiid flies
Limnophora	
Crustacea	
Amphipoda	Scuds
Gammaridae	
Gammarus	
MOLLUSCA	
Gastropoda	
Pulmonata	Snails
Physidae	
Physa	

Table II C-11 PERIPHYTON PRODUCTIVITY ESTIMATES FOR PICEANCE BASIN STATION, JANUARY 1976

Station No.	Dry Weight (gm)	Ash Free Weight (gm)	Productivity (gm ash free wt/day/m^2)
Piceance Creek			
P-3	0.0049	0.0022	0.0258
P-3	0.0146	0.0118	0.1385
P-3	0.0033	0.0017	0.0199
P-6	0.0049	0.0008	0.0093
P-6	0.0005	0.0000	0.0000
P-6	0.0029	0.0010	0.0117
Stewart Creek & Lakes			
S-1	0.0042	0.0034	0.0399
S-1	0.0091	0.0075	0.0880
S-1	0.0046	0.0036	0.0422
LSL (H)*	0.0226	0.0177	0.2077
LSL (H)*	0.0103	0.0060	0.0704
LSL (H)*	0.0213	0.0168	0.1972
LSL (V)*	0.0236	0.0159	0.1866
LSL (V)*	0.0325	0.0233	0.2735
LSL (V)*	-	-	-
Willow Creek & Lakes			
W-3	0.0081	0.0061	0.0716
W-3	0.0195	0.0162	0.1901
W-3	0.0052	0.0039	0.0457
UWL	0.0162	0.0090	0.1056
UWL	0.0240	0.0154	0.1807
UWL	0.0525	0.0363	0.4261
LWL	0.0107	0.0059	0.0692
LWL	0.0104	0.0054	0.0633
LWL	0.0082	0.0039	0.0457

---

* (H) Horizontally positioned substrate (slide)
(V) Vertically positioned substrate (slide)

values were negligible as has been found previously (Table II C-12). The amount of carbon fixed, which is an indication of the amount of photosynthesis, varied from 52.50 mg carbon fixed/m^3 to 198.75 mg carbon fixed/m^3 for an eight-hour exposure period.

Water Quality

Water quality samples were analyzed for common minerals and nutrients, total hardness, total alkalinity, total dissolved solids, bacteria, and pathogens. For most stations sampled the total dissolved solids had increased in January over those values for November. No disease pathogens were detected in the samples from the station examined.

Sediment Analysis

In most cases there was an increase in fine sediment particles in January compared to November.

Springs and Seeps

Eight springs and seeps, sampled in November, are discussed in Quarterly Data Report #6. Most of the springs had noticeably higher flows in November compared to July 1975. However, Spring 8, along Willow Creek near the mouth of Scandard Gulch, was dry for the first few meters below its original source and had a lesser flow than in March or July 1975. With the exception of flatworms, invertebrates collected in the springs and seeps are also found at the other aquatic sampling stations.

Other Studies

Other researchers have conducted studies at some of the same stations or at similar stations as those being used in this study. These studies have been detailed in the data report under the station descriptions in the Scope of Study section.

Everhart and May (1973) and May (1970) who both report on the same study, conducted studies on water quality, benthic invertebrates and fish. They reported similar results to the Tract C-b findings for water quality and benthos at Stations P-1, P-5A, and P-7. Water temperatures were higher in summer during their study. Their results for the White River station (WR-1) showed higher water temperatures in summer, lower conductivity and dissolved oxygen readings, but similar pH and benthos findings.

They reported five species of fish from Piceance Creek: Bonytail Chub (Gila elegans), black Bullhead (Ictalurus melas), red shiner (Notropis lutrensis), mountain whitefish (Prosopium williamsoni) and the mottled sculpin (Cottus bairdi) which have not been taken in Piceance

Table II C-12 LIGHT AND DARK BOTTLE DISSOLVED OXYGEN DETERMINATIONS[1] FOR UPPER AND LOWER WILLOW LAKES AND UPPER[2] AND LOWER STEWART LAKES, JANUARY 1976

Station & Replicate	Time of Exposure	Temp. (°C)	Light Bottle D.O. (mg/l)	Dark Bottle D.O. (mg/l)	D.O. Sample from lake[3] (mg/l)
Lower Stewart Lake					
1.	Initial	5.5	-	-	4.99
2.	Initial	5.5	-	-	4.99
1.	8 hours	6.5	4.92	4.92	
2.	8 hours	6.5	4.92	4.92	
Upper Willow Lake					
1.	Initial	4.0	-	-	4.50
2.	Initial	4.0	-	-	4.57
1.	8 hours	8.0	4.57	4.43	
2.	8 hours	8.0	5.28	4.36	
Lower Willow Lake					
1.	Initial	7.0	-	-	2.88
2.	Initial	7.0	-	-	-
1.	7½ hours	7.5	2.81	2.60	
2.	7½ hours	7.5	2.88	2.81	

---

1. Computed by Modified Winkler Method (Azide Modification).
2. Upper Stewart Lake frozen over in January 1976.
3. Taken when light and dark bottles were placed in the lake.

Creek during this study. The mottled sculpin and mountain whitefish have been collected at the Tract C-b White River stations.

Pettus (1974) reports the mountain sucker from Piceance Creek. His sampling at Tract C-b White River station (WR-2) yielded the bluehead mountain sucker and the white sucker which have not been collected in this study.

Pennak (1974) found similar water quality results for Stations WR-1 and WR-2 examined in this study.

Woodling and Kendall (1974) found similar results for water quality and benthos at Stations P-2, P-6, S-1, and W-3 examined in this study. They report the bluehead sucker from Piceance Creek which is very similar to the mountain sucker collected in C-b studies.

II C-3 Terrestrial Vegetation Studies

The remainder of the results from the 1975 herb-production studies and a summarization of stem-age data collected in conjunction with the shrub-production studies are reported in this section.

The standing-dead plant biomass and the litter and prostrate-dead plant biomass undergo seasonal fluctuations (Figure II C-2). During the winter the standing crop consists mainly of these two fractions although some live herbs may be found in most of the plant communities. During the growing season, however, the standing-dead and the litter and prostrate-dead fractions become inconspicuous as the live biomass increases. The standing-dead fractions (percentage distribution) reached their maximum in August for nearly all of the sites as expected, while the litter and prostrate-dead fractions reached their maximums in May at most sites (Table II C-13). A large amount of the latter fraction is expected early in the year since the harsh winter weather would cause much of the standing-dead to be converted into the litter layer.

The stem ages from the clipped shrub samples showed some interesting differences among the chained-rangeland sites and sagebrush sites as well as differences among species (Figures II C-3, 4 and 5). In the chained areas (Plots 1 and 2) most of the sagebrush plants are less than 10 years old and only a small percentage of the population is more than 20 years old (Figure II C-3). Similar age results were also obtained for serviceberry, mountain mahogany, bitterbrush, and rabbitbrush (Figure II C-4).

Age distribution for saplings of pinyon pine and Utah juniper in the chained rangeland show very different patterns (Figure II C-5). Ages ranged from 7 to 43 years with each age class well represented. The data suggest that these saplings were not removed by the range improvement process.

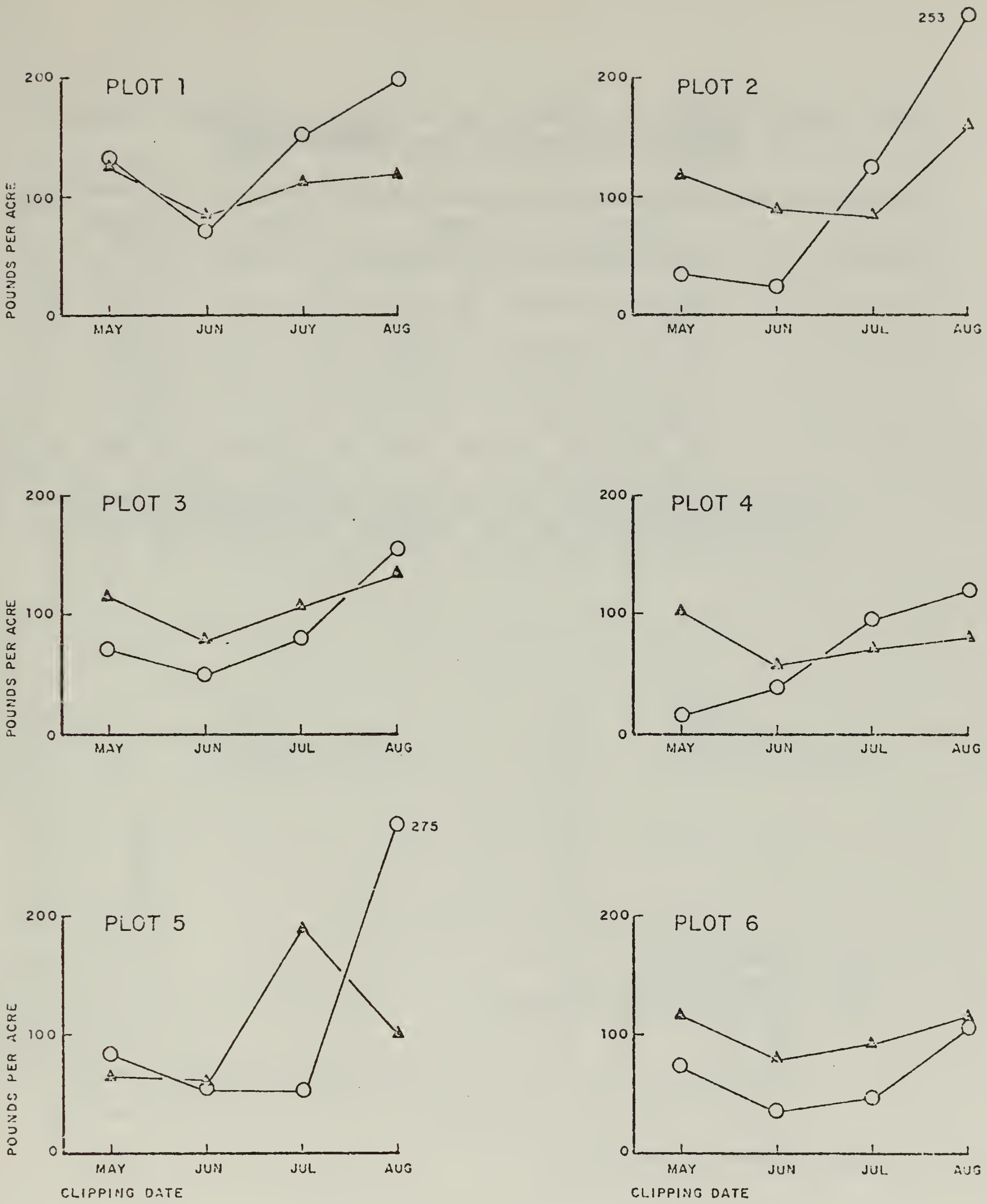


Figure II C-2
Seasonal variation in the standing dead and the litter and prostrate dead fractions of the herb layer. (1975 data)

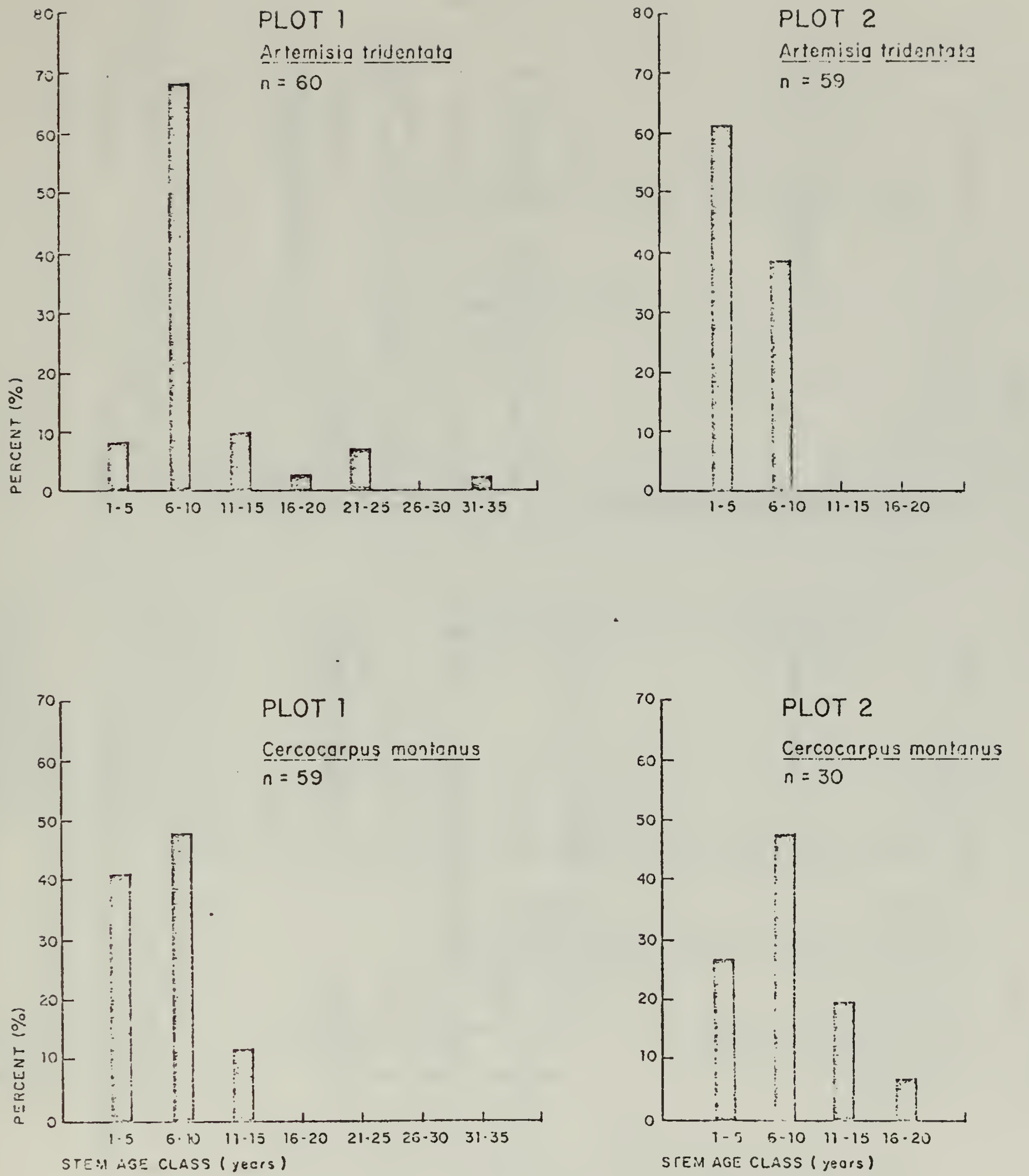
Table II C-13 PERCENTAGE DISTRIBUTION OF HERB STANDING CROP AT EACH CLIPPING DATE FOR THE 1975 GROWING SEASON

	May			June			July			August		
Plot No.	CL[1]	SD[1]	LPD[1]	CL	SD	LPD	CL	SD	LPD	CL	SD	LPD
1	32	34	34*	67*	15	17	67*	19	14	45	35*	20
2	45	13	42*	71*	6	23	65	21	14	36	39*	25
3	59	16	25*	78*	9	13	73	12	15	56	25*	19
4	37	9	54*	74*	11	16	57	25	18	38	38*	25
5	30	39	31	61*	19	20	46	12	42*	25	55*	20
6	36	24*	40*	65*	11	24	61	13	26	56	22	22

---

[1] CL = Current Live
SD = Standing Dead
LPD = Litter and Prostrate Dead

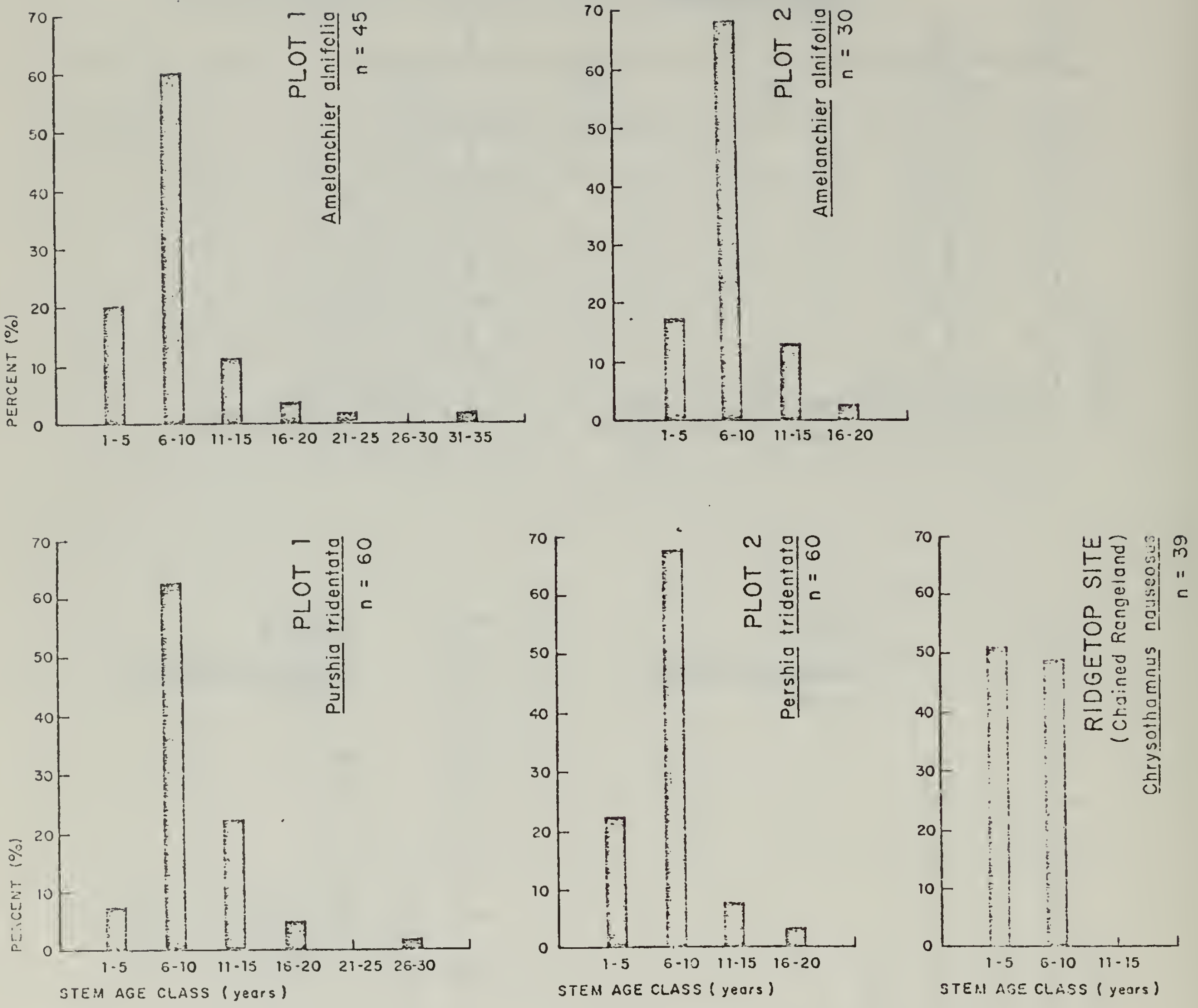
* Yearly maximum percentage



NOTE :

n = Sample size

Figure II C-3
Stem age frequency distributions for big sagebrush (*Artemisia tridentata*) and mountain mahogany (*Cercocarpus montanus*).



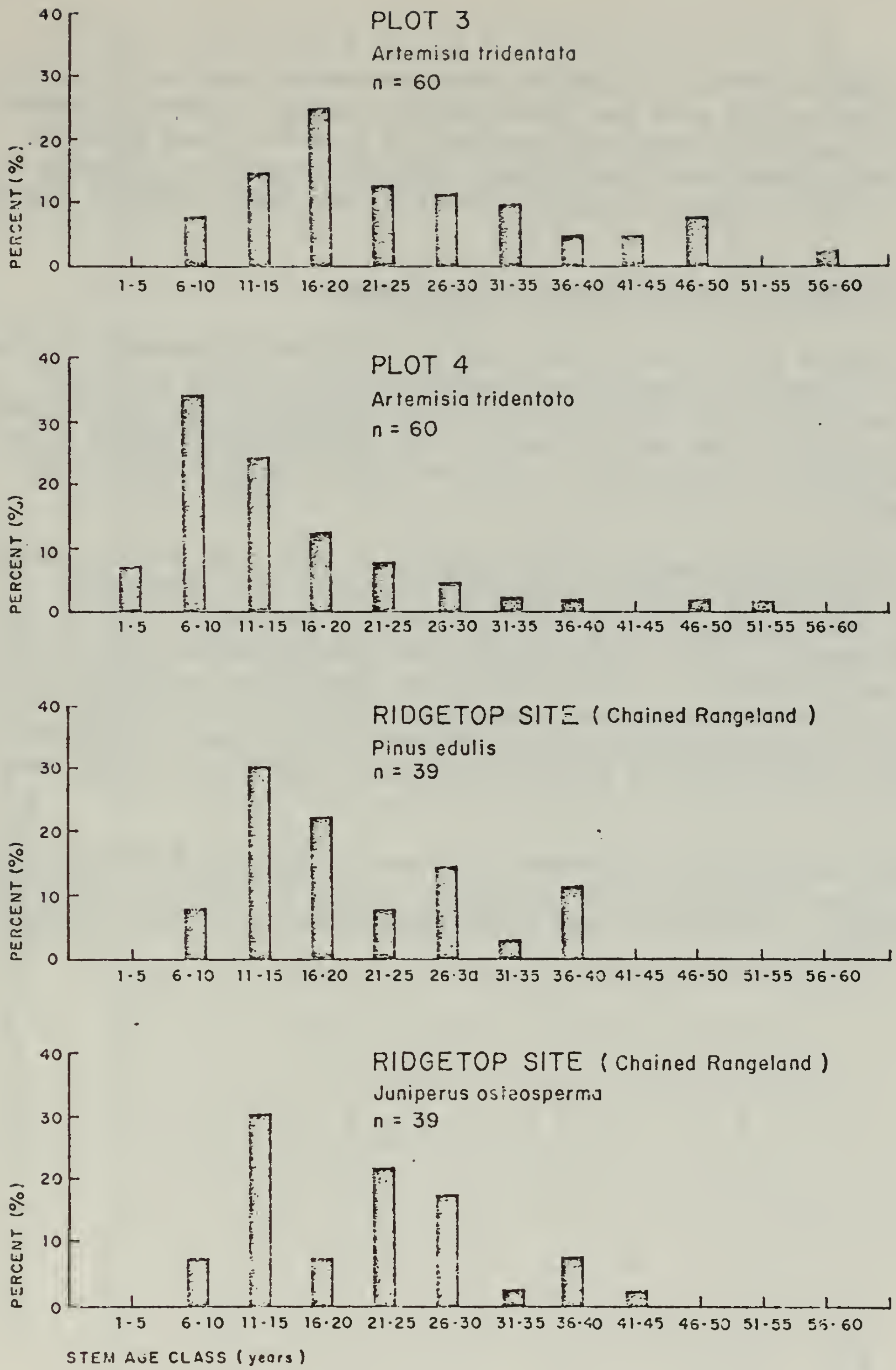
NOTE:

n = Sample size

Figure II C-4

Stem age frequency distributions for serviceberry (Amelanchier alnifolia), bitterbrush (Purshia tridentata) and rabbitbrush (Chrysothamnus nauseosus)

Proj 74-669	Date 25 Mar 1976	Draft W.W.	Appd



NOTE :

n = Sample size

Figure II C-5
Stem age frequency distributions for big sagebrush (*Artemisia tridentata*), pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*).

Proj 74 - 669	Date 25 Mar 1976	Draft W. W.	Appd

While the sagebrush in chained areas are mostly less than ten years old, the sagebrush in both the upland and bottomland sagebrush communities shows a much more even age-distribution pattern. Some stems in these two areas were more than 50 years old and suggest a long term dominance by this species in upland clearings and small canyon bottomlands.

II C-4 Soil Survey and Productivity Assessment

The results of the soil survey and productivity assessment studies for Tract C-b and the one-mile surrounding area have been presented in past Quarterly Data and Summary Reports (cf. Quarterly Data and Summary Reports #3 and #5), and are included in the Detailed Development Plan and the first year environmental baseline program Annual Summary and Trends Report.

During the sixth quarter additional soils data have been gathered for use in developing interrelationships for soils and vegetation. These data have not been fully analyzed but are presented here for continuity (Table II C-14). Data analysis and interpretation will appear when they are completed. Also included for the sake of continuity, are summary tables of all soils data collected (Table II C-14 through II C-16), a map of all soil sampling locations (Figure II C-6)*, and a summary of the salient characteristics of each major soil type in the study area (Table II C-17).

Studies involving soil productivity were completed during the third quarter of baseline study. The completed report is found in the Quarterly Data Report #3, June 1975, and no further reporting of this study will be made.

---

* Figure II C-6 indicates sample location by number keyed to the various collectors. The soil types that were sampled can be inferred from this figure.

Table II C-14 AGRONOMIC CHARACTERISTICS OF ADDITIONAL SOIL SAMPLES TAKEN ON TRACT C-b
(C-b Staff Samples)

SAMPLE NO.	ANALYSIS																				
	TEXTURE	%ORGANIC	%LIME	PH-H2O	CEC	ESP	SALT-EC	OMN	CALCIUM	MAGNESIUM	POTASSIUM	SODIUM	ZINC	IRON	MANGANESE	COPPER	PHOSPHORUS	SULFATE-S	NITRATE-N	AMMONIA-N	BORON
7	SN CL LO	2.4	8.5	8.3	37.1	1.2	0.7	96.0	5400.0	390.0	140.0	100.0	0.1	1.6	0.9	0.2	8.0	30.0	5.0	0.6	0.5
8	CL LO	2.1	8.8	8.4	34.4	1.6	0.7	84.0	5000.0	360.0	70.0	120.0	0.1	1.2	0.9	0.3	1.0	16.0	10.0	1.0	0.4
9	SN CL LO	3.0	5.9	8.1	32.2	1.6	1.0	120.0	4900.0	220.0	130.0	120.0	0.2	5.3	1.7	0.3	18.0	20.0	20.0	2.0	0.6
10	SN CL LO	4.6	4.5	8.2	34.3	1.4	0.9	120.0	5200.0	240.0	130.0	110.0	0.1	3.0	1.5	0.3	11.0	5.0	12.0	2.0	0.6
11	SL CL LO	2.3	5.9	8.3	35.7	1.1	0.8	92.0	4700.0	740.0	80.0	90.0	0.3	2.4	1.3	0.4	2.0	25.0	4.0	0.5	0.5
12	SL CL LO	2.4	7.3	8.2	33.7	1.2	0.8	96.0	4900.0	370.0	93.0	90.0	0.1	4.4	1.3	0.3	6.0	25.0	7.0	0.9	0.6
13	SN CL LO	2.3	9.0	8.3	31.5	1.4	0.7	92.0	4800.0	190.0	46.0	100.0	0.1	2.0	1.0	0.2	1.0	12.0	7.0	0.8	0.4
14	SN CL LO	3.5	7.4	8.2	41.1	1.1	0.8	120.0	6100.0	390.0	89.0	110.0	0.4	3.0	1.5	0.3	9.0	18.0	7.0	1.3	0.6
15	CL LO	2.4	1.3	8.1	33.2	1.1	0.7	96.0	4500.0	580.0	95.0	80.0	0.6	4.5	3.0	0.5	2.0	20.0	4.0	0.5	0.5
16	SN CL LO	3.7	5.8	8.2	30.9	1.7	0.8	120.0	4600.0	240.0	130.0	120.0	0.4	4.4	2.1	0.3	6.0	40.0	14.0	2.0	0.7
18	SN LO	2.7	7.4	8.6	27.4	7.9	1.4	100.0	3600.0	350.0	360.0	460.0	0.1	4.8	1.5	0.4	4.0	35.0	10.0	1.3	0.7
19	SN LO	2.0	3.8	8.2	25.6	2.2	1.1	90.0	3800.0	190.0	230.0	120.0	0.1	4.1	1.7	0.3	2.0	25.0	15.0	1.5	0.6
21	SL LO	4.3	7.6	8.1	37.2	1.9	0.9	120.0	5600.0	280.0	70.0	160.0	0.1	7.0	2.5	0.3	14.0	30.0	5.0	1.1	0.6
22	SN LO	2.1	4.5	8.3	31.5	2.0	0.9	94.0	4700.0	250.0	110.0	140.0	0.2	3.1	1.1	0.3	1.0	20.0	7.0	0.7	0.6
28	SN LO	1.4	5.1	8.5	21.4	4.7	1.1	63.0	3100.0	180.0	100.0	220.0	0.1	3.2	1.4	0.3	2.0	25.0	9.0	0.7	0.6
29	SN LO	2.8	1.5	8.0	34.3	1.2	0.9	100.0	5000.0	390.0	85.0	90.0	0.1	5.6	3.0	0.3	3.0	18.0	4.0	0.5	0.5
30	SN LO	1.2	5.0	8.3	30.0	1.8	0.9	54.0	4700.0	110.0	51.0	120.0	0.1	2.7	1.2	0.3	1.0	20.0	12.0	0.7	0.5
31	SN LO	2.5	5.6	8.3	27.4	2.3	1.0	100.0	3900.0	300.0	240.0	140.0	0.5	6.6	7.2	0.6	2.0	25.0	11.0	1.3	1.0

ALL VALUES, EXCEPT WHERE OTHERWISE INDICATED,
ARE PARTS PER MILLION (PPM), AVAILABLE

Table II C-15 CHEMICAL AND PHYSICAL ANALYSES OF SOIL SAMPLES COLLECTED ON TRACT C-b

(SCS Soil Sampling Locations)

DRILL HOLE NUMBER AND INTERVAL		% OM	PERCENT LIME	OMN (6)	pH (1)	SALT EC. (4)	CEC (2)	ESP (3)	SAR (5)	GYP.	Fld Cap (7)	WILT pt. (8)	SATURATED SOIL EXTRACT meg./liter										EXCHANGEABLE CATIONS meg./liter				
													Ca	Mg	Na	K	TOTAL CATIONS	SO_4	Cl	CO_3	HCO_3	TOTAL ANIONS	Ca	Mg	Na	K	TOTAL
1	0 - 6"	1.9	8.1	85.5	8.7	8.7	17.1	10.0	16.9	-0.1	18.4	6.5	10.2	16.2	61.5	3.7	91.6	70.7	4.4	0.0	16.1	91.2	7.5	6.9	1.7	1.0	17.1
1	6"-16"	3.7	8.5	120.0	8.6	4.4	26.3	13.0	11.9	-0.1	35.2	21.7	5.1	8.2	30.8	1.9	46.0	27.6	2.3	0.0	15.5	45.4	11.1	11.0	3.4	0.7	26.3
1	16"-31"	1.2	6.3	54.0	8.4	4.4	18.9	2.1	12.2	-0.1	16.8	7.4	5.3	7.8	31.4	1.9	46.4	8.4	5.6	0.0	31.8	45.8	16.2	2.1	0.4	0.2	18.9
1	31"-60"	1.3	6.3	58.5	8.5	2.7	14.9	0.3	4.2	-0.1	16.3	6.7	12.7	2.8	11.6	1.3	28.4	3.4	0.9	0.0	23.7	28.0	13.3	1.4	0.0	0.2	14.9
2	0 - 7"	1.9	1.5	76.0	8.2	1.4	22.5	0.4	2.6	-0.1	31.7	16.2	7.2	1.6	5.4	0.5	14.7	1.7	0.6	0.0	12.2	14.5	19.5	2.8	0.1	0.1	22.5
2	7"-11"	0.9	8.7	36.0	8.4	1.0	20.0	0.8	2.2	-0.1	32.1	19.0	5.1	1.0	3.8	0.4	10.0	0.3	0.3	0.0	9.6	10.2	15.1	4.7	0.2	0.1	20.0
2	11"-17"	1.3	5.4	58.5	8.3	1.6	15.9	0.3	2.8	-0.1	18.5	6.9	8.4	1.8	6.3	0.6	17.1	0.9	0.8	0.0	15.1	16.9	14.1	1.2	0.0	0.6	15.9
2	17"-28"	1.0	6.7	45.0	8.4	1.6	17.6	0.9	2.7	-0.1	16.4	7.6	8.2	2.0	6.1	0.6	16.8	1.2	0.7	0.0	14.6	16.6	16.1	1.2	0.1	0.2	17.6
2	28"-50"	-	4.5	-	8.6	6.4	25.3	7.5	11.8	-0.1	25.3	15.1	9.2	15.4	41.5	1.1	67.3	45.9	0.6	0.0	19.9	66.3	12.4	10.7	1.9	0.3	25.3
3	0 - 1"	2.1	8.4	84.0	8.3	2.7	23.1	5.1	4.2	-0.1	31.2	23.3	12.2	3.6	11.9	1.0	28.7	13.5	1.3	0.0	13.5	28.3	12.0	9.7	1.2	0.1	23.1
3	1"- 8"	2.0	2.0	80.0	8.2	1.5	16.5	0.5	2.6	-0.1	27.1	17.9	7.2	2.2	5.7	0.6	15.6	1.9	0.8	0.0	12.7	15.4	14.0	2.3	0.1	0.2	16.5
3	8"-15"	1.5	8.7	60.0	8.7	2.7	24.7	28.0	4.4	-0.1	32.4	18.1	11.6	3.5	12.1	0.9	28.2	1.8	1.8	0.0	24.1	27.8	12.1	5.5	6.9	0.1	24.7
4	0 - 2"	1.6	8.8	64.0	8.4	1.3	22.6	1.8	2.6	-0.1	33.0	20.6	6.2	2.1	5.2	0.7	14.1	0.5	0.4	0.0	13.0	13.9	17.5	4.5	0.4	0.1	22.6
4	2"- 6"	0.6	8.9	27.0	8.6	7.9	20.6	27.2	3.4	-0.1	17.8	7.3	53.9	8.3	19.2	2.0	83.5	5.5	5.3	0.0	71.6	82.3	8.2	6.7	5.6	0.0	20.6
4	6"-14"	2.3	1.9	92.0	8.1	4.3	17.1	0.8	1.4	-0.1	30.8	19.5	33.3	5.0	5.9	1.2	45.4	2.3	2.6	0.0	39.8	44.8	14.7	2.0	0.1	0.3	17.1
4	14"-21"	1.8	1.1	72.0	7.9	2.8	19.6	0.4	1.7	-0.1	34.6	21.8	19.9	3.1	5.8	0.7	29.4	1.5	1.3	0.0	26.2	29.0	15.0	4.3	0.1	0.2	19.6
4	21"-43"	0.3	1.7	36.0	8.3	3.2	18.3	0.9	2.2	-0.1	15.5	7.0	21.6	3.3	7.6	0.8	33.3	1.4	1.2	0.0	30.3	32.8	14.9	3.2	0.2	0.1	18.3
4	43"-62"	1.3	7.4	52.0	8.4	5.0	20.5	4.5	2.7	-0.1	30.4	21.5	33.6	5.3	12.1	1.3	52.1	2.2	2.5	0.0	46.6	51.4	16.0	3.5	0.9	0.0	20.5
5	0 - 8"	1.4	3.4	56.0	8.3	1.8	23.0	0.2	4.5	-0.1	34.8	20.6	6.8	2.4	9.7	0.5	19.5	0.7	0.7	0.0	17.8	19.2	18.5	4.3	0.0	0.1	23.0
5	8"-17"	1.0	9.2	40.0	8.4	2.1	20.9	2.3	4.6	-0.1	27.2	19.7	8.0	2.8	10.6	0.6	21.9	0.6	0.7	0.0	20.2	21.6	13.9	6.4	0.5	0.1	20.9
5	17"-29"	-	2.0	-	7.8	2.8	18.7	0.5	1.2	-0.1	26.1	13.6	17.7	6.2	4.3	1.3	29.4	2.6	3.1	0.0	23.4	29.0	15.3	2.6	0.1	0.7	18.7
6	0 - 2"	1.6	1.6	64.0	8.2	1.2	19.2	0.7	2.1	-0.1	32.2	17.0	6.3	1.3	4.1	0.6	12.3	0.7	0.4	0.0	11.0	12.1	16.6	2.4	0.1	0.1	19.2
6	2"- 6"	1.4	1.9	63.0	8.0	1.7	17.8	0.3	2.5	-0.1	18.2	6.3	9.2	2.0	5.9	0.9	17.9	1.6	0.9	0.0	15.2	17.7	16.0	1.4	0.1	0.3	17.8
6	6"-19"	2.3	6.5	92.0	8.1	1.5	18.9	0.3	2.4	-0.1	31.7	16.8	8.0	1.8	5.2	0.7	15.7	0.6	0.7	0.0	14.1	15.5	17.4	1.2	0.0	0.2	18.9
8	0 - 6"	2.7	2.3	108.0	7.9	1.4	21.5	0.5	2.0	-0.1	27.5	18.8	7.0	2.4	4.3	1.0	14.8	0.2	0.9	0.9	13.5	14.6	17.5	3.3	0.1	0.9	21.5
9	0 - 5"	0.5	2.4	22.5	8.3	1.3	20.5	0.8	2.7	-0.1	17.7	7.5	4.9	2.3	5.1	1.0	13.3	0.5	0.5	0.0	12.2	13.1	18.2	2.0	0.2	0.1	20.5
9	5"- 9"	2.5	0.9	100.0	7.7	1.6	15.1	0.3	2.5	-0.1	29.8	18.5	6.6	3.1	5.5	1.3	16.6	1.5	1.1	0.0	13.7	16.4	11.0	3.5	0.0	0.4	15.1
9	9"-18"	1.9	1.5	76.0	7.9	1.4	21.6	0.2	2.3	-0.1	32.0	21.7	6.3	2.8	5.0	1.2	15.2	1.0	0.8	0.0	13.2	15.0	17.0	4.4	0.0	0.2	21.6
10	0 - 5"	3.4	5.2	100.0	8.1	2.1	20.4	0.5	2.6	-0.1	18.2	7.2	10.8	3.1	6.9	1.4	22.1	0.1	1.6	0.0	20.1	21.8	18.9	1.2	0.1	0.2	20.4
10	5"-11"	4.5	1.4	120.0	7.8	1.6	19.0	0.2	2.2	-0.1	25.3	13.4	8.5	2.2	5.1	1.0	16.7	0.3	1.2	0.0	15.0	16.5	16.4	2.1	0.0	0.4	19.0
10	11"-19"	3.3	7.1	120.0	8.3	3.3	16.0	7.3	3.2	-0.1	32.7	19.9	17.3	4.5	10.6	2.1	34.6	10.9	2.2	0.0	21.0	34.1	8.6	6.1	1.2	0.1	16.0
11	0 - 5"	1.2	1.0	48.0	8.0	1.5	21.0	0.2	2.4	-0.1	35.4	21.0	7.1	2.8	5.4	0.6	15.8	1.2	0.8	0.0	13.6	15.6	15.9	4.9	0.0	0.1	21.0
11	5"-11"	0.9	8.7	36.0	8.5	1.7	19.9	1.6	3.4	-0.1	29.2	16.6	8.0	2.1	7.7	0.7	18.4	0.5	0.6	0.0	17.1	18.2	12.9	6.6	0.3	0.0	19.9
11	12"-17"	0.6	9.1	27.0	8.8	2.9	20.9	19.0	3.4	-0.1	17.0	7.2	13.7	5.4	10.4	1.2	30.7	2.3	1.7	0.0	26.3	30.2	8.8	8.1	4.0	0.0	20.9
11	17"-25"	1.8	8.6	72.0	8.4	1.6	18.7	0.2	3.2	-0.1	27.7	16.5	7.2	1.9	7.0	0.6	16.8	0.7	0.5	0.0	15.3	16.5	17.0	1.6	0.0	0.0	18.7
11	25"-50"	1.7	1.6	76.5	8.2	2.2	20.5	0.2	3.3	-0.1	15.9	6.4	10.8	3.1	8.6	1.0	23.5	1.6	1.0	0.0	20.5	23.1	16.9	3.4	0.0	0.1	20.5
12	0 - 6"	3.6	5.3	120.0	9.5	7.5	19.2	42.7	52.3	-0.1	31.1	18.6	2.9	1.2	74.5	0.6	79.1	63.8	3.8	3.3	7.8	78.7	9.8	0.7	8.2	0.4	19.2
12	6"-16"	1.3	4.8	58.0	8.2	0.7	14.5	7.6	1.3	-0.1	16.8	6.3	3.0	1.6	2.0	0.4	7.0	3.6	0.5	0.0	2.8	6.9	12.3	0.7	1.1	0.3	14.5
12	16"-21"	2.0	5.6	90.0	8.3	0.7	16.4	4.0	1.2	-0.1	17.2	6.9	3.5	2.0	2.0	0.4	7.8	3.7	0.4	0.0	3.6	7.7	13.8	1.5	0.6	0.5	16.4
12	21"-60"	0.8	4.6	36.0	8.4	0.8	19.0	2.9	1.1	-0.1	17.0	6.8	3.9	2.1	2.0	0.5	8.5	1.1	0.4	0.0	6.9	8.3	16.8	1.5	0.6	0.2	19.0

DRILL HOLE NUMBER AND INTERVAL		PLANT NUTRIENTS ppm											TRACE ELEMENTS ppm									GROSS RADIO-ACTIVITY SCAN (9)			
		Zn	Fe	Mn	Cu	P	SO_4-S	K	NO_3-N	NH_4-N	B	Mo	Co	Se	As	F	Ni	Pb	Hg	Cd	Sb	ALPHA +	ALPHA -	BETA +	BETA -
1	0 - 6"	0.4	98.0	17.0	1.5	16.0	990.0	460.0	30.0	2.8	0.7	0.9	0.2	0.03	0.06	0.36	1.3	-1.0	0.001	-0.1	-1.0	20	5	31	8
1	6"-16"	0.4	83.0	18.0	2.7	11.0	600.0	340.0	66.5	12.3	0.6	0.7	0.2	0.04	0.03	0.32	3.0	-1.0	0.001	-0.1	-1.0	16	4	26	6
1	16"-31"	0.1	2.7	3.1	0.4	9.0	50.0	110.0	20.1	1.2	0.2	0.4	0.1	0.03	0.04	0.29	0.7	-1.0	0.001	-0.1	-1.0	17	4	19	6
1	31"-60"	0.1	2.2	3.6	0.3	3.0	29.0	90.0	14.6	1.0	0.3	0.2	-0.1	0.02	0.02	0.31	0.4	-1.0	0.001	-0.1	-1.0	14	4	20	6
2	0 - 7"	0.1	3.4	7.2	0.6	5.0	31.0	65.0	23.6	2.2	0.6	0.7	0.1	0.01	0.03	0.21	1.4	-1.0	0.001	-0.1	-1.0	19	5	29	7
2	7"-11"	0.1	1.2	3.0	0.4	2.0	8.0	39.0	14.1	0.6	0.2	0.4	-0.1	0.02	0.04	0.11	1.0	-1.0	0.001	-0.1	-1.0	20	5	26	7
2	11"-17"	0.1	2.3	3.6	0.3	7.0	11.0	230.0	30.0	1.9	0.3	0.2	-0.1	0.02	0.08	0.12	0.6	-1.0	0.001	-0.1	-1.0	17	4	22	5
2	17"-28"	0.1	1.9	3.3	0.3	7.0	16.0	73.0	20.1	1.0	0.3	0.2	0.1	0.01	0.07	0.23	0.6	-1.0	0.001	-0.1	-1.0	14	4	23	5
2	28"-50"	2.4	87.0	19.0	1.8	9.0	650.0	160.0	72.0	17.6	0.9	0.1	0.2	0.01	0.06	0.24	2.3	-1.0	0.001	-0.1	-1.0	16	4	21	5
3	0 - 1"	0.2	64.0	15.0	2.3	10.0	270.0	85.0	24.6	2.6	0.2	1.1	0.2	-0.01	0.04	0.51	2.6	-1.0	0.001	-0.1	-1.0	20	5	30	6
3	1"- 8"	0.2	1.6	4.4	0.6	7.0	34.0	84.0	25.6	2.6	0.3	0.8	0.1	0.01	0.03	0.48	1.1	-1.0	0.001	-0.1	-1.0	18	4	24	6
3	8"-15"	0.1	2.1	8.2	0.6	8.0	26.0	77.0	44.6	3.3	2.1	0.7	-0.1	-0.01	0.04	0.36	1.1	-1.0	0.001	-0.1	-1.0	17	4	21	6
4	0 - 2"	0.1	1.3	4.8	0.7	3.0	10.0	49.0	16.5	1.3	0.4	0.3	-0.1	0.01	0.07	0.21	1.3	-1.0	0.001	-0.1	-1.0	18	4	22	6
4	2"- 6"	0.1	1.8	7.4	0.2	2.0	17.0	32.0	13.5	0.4	0.4	0.5	-0.1	0.01	0.06	0.22	1.0	-1.0	0.001	-0.1	-1.0	16	4	23	6
4	6"-14"	0.2	3.3	6.9	0.7	14.0	12.0	150.0	38.1	4.4	0.8	0.3	-0.1	0.01	0.05	0.26	0.8	-1.0	0.001	-0.1	-1.0	20	5	27	6
4	14"-21"	0.2	3.9	10.0	0.9	11.0	11.0	110.0	28.8	2.6	0.4	0.7	-0.1	-0.01	0.07	0.24	1.4	-1.0	0.001	-0.1	-1.0	14	4	31	6
4	21"-43"	0.1	2.7	2.0	0.2	2.0	8.0	37.0	14.6	0.6	0.2	0.6	-0.1	-0.01	0.05	0.26	0.7	-1.0	0.001	-0.1	-1.0	14	4	29	6
4	43"-62"	0.1	1.3	3.9	0.6	1.0	13.0	47.0	20.9	1.4	1.9	0.8	-0.1	-0.01	0.06	0.21	1.0	-1.0	0.001	-0.1	-1.0	16	4	34	6
5	0 - 8"	0.1	1.7	6.5	0.8	6.0	10.0	50.0	18.6	1.3	0.4	0.3	0.1	-0.01	0.03	0.30	1.2	-1.0	0.003	-0.1	-1.0	19	5	34	6
5	8"-17"	0.2	1.8	5.5	0.6	1.0	8.0	38.0	15.8	0.8	0.5	0.1	-0.1	-0.01	0.02	0.34	1.0	-1.0	0.002	-0.1	-1.0	15	4	22	6
5	17"-29"	5.5	15.0	9.8	0.8	26.0	17.0	290.0	99.0	22.8	1.3	0.1	0.2	-0.01	0.03	0.32	0.7	-1.0	0.001	-0.1	-1.0	14	4	24	6
6	0 - 2"	0.1	1.4	5.2	0.4	1.0	15.0	51.0	20.1	1.6	0.3	0.7	-0.1	-0.01	0.07	0.18	1.1	-1.0	0.004	-0.1	-1.0	20	5	25	6
6	2"- 6"	0.3	4.1	4.3	0.3	4.0	15.0	130.0	33.8	2.4	0.4	0.9	-0.1	-0.01	0.06	0.17	1.1	-1.0	0.003	-0.1	-1.0	19	5	23	8
6	6"-19"	0.1	4.8	4.9	0.4	10.0	9.0	90.0	27.7	3.2	0.4	0.5	-0.1	-0.01	0.03	0.21	1.0	-1.0	0.002	-0.1	-1.0	16	4	24	6
8	0 - 6"	0.2	3.9	2.6	0.4	14.0	2.0	230.0	50.3	6.8	1.0	0.4	-0.1	-0.01	0.03	0.21	0.8	-1.0	0.002	-0.1	-1.0	18	4	31	6
9	0 - 5"	0.1	2.7	0.9	0.2	1.0	7.0	53.0	12.0	0.3	0.2	0.5	-0.1	-0.01	0.06	0.18	0.8	-1.0	0.003	-0.1	-1.0	19	5	29	6
9	5"- 9"	0.4	7.7	5.9	0.9	18.0	17.0	210.0	56.7	7.1	0.7	0.3	-0.1	-0.01	0.04	0.17	1.3	-1.0	0.002	-0.1	-1.0	14	4	28	6
9	9"-18"	0.3	5.3	11.0	0.9	11.0	16.0	94.0	30.0	2.8	0.4	0.2	-0.1	-0.01	0.04	0.14	1.6	-1.0	0.002	-0.1	-1.0	13	4	30	6
10	0 - 5"	0.2	4.8	2.4	0.9	6.0	1.0	93.0	39.6	6.7	0.6	0.3	-0.1	0.02	0.08	0.37	0.9	-1.0	0.001	-0.1	-1.0	18	4	31	6
10	5"-11"	0.5	8.0	7.1	0.5	10.0	3.0	180.0	56.7	12.8	1.0	0.1	0.1	0.01	0.11	0.32	1.2	-1.0	0.001	-0.1	-1.0	16	4	21	6
10	11"-19"	0.2	72.0	10.0	1.7	2.0	130.0	92.0	50.3	8.3	0.3	0.1	0.2	-0.01	0.57	0.45	2.4	-1.0	0.001	-0.1	-1.0	16	4	24	7
11	0 - 5"	0.1	3.0	6.8	0.8	1.0	19.0	55.0	35.1	2.1	0.2	0.4	-0.1	-0.01	0.06	0.31	1.5	-1.0	0.005	-0.1	-1.0	20	5	29	6
11	5"-11"	0.2	0.8	2.7	0.4	1.0	8.0	30.0	12.0	0.5	0.1	0.3	-0.1	-0.01	0.03	0.26	0.7	-1.0	0.003	-0.1	-1.0	18	4	20	6
11	12"-17"	0.1	0.7	1.8	0.4	1.0	22.0	41.0	11.1	0.3	0.2	0.3	-0.1	-0.01	0.07	0.29	0.9	-1.0	0.003	-0.1	-1.0	17	4	19	6
11	17"-25"	0.1	1.0	1.9	0.3	2.0	12.0	34.0	20.9	1.9	0.3	0.2	-0.1	-0.01	0.08	0.26	1.0	-1.0	0.002	-0.1	-1.0	15	4	20	6
11	25"-50"	0.1	6.1	2.6	0.3	2.0	13.0	59.0	31.2	2.7	0.4	0.2	-0.1	-0.01	0.06	0.21	1.5	-1.0	0.002	-0.1	-1.0	15	4	18	6
12	0 - 6"	0.3	27.0	13.0	1.2	11.0	4800.0	190.0	52.0	2.0	0.6	0.5	-0.1	-0.01	0.04	0.31	1.1	-1.0	-0.001	-0.1	-1.0				
12	6"-16"	0.1	2.6	0.8	0.3	2.0	210.0	140.0	7.0	0.5	0.2	0.4	0.1	0.02	0.03	0.34	0.6	-1.0	-0.001	-0.1	-1.0				
12	16"-21"	0.1	2.2	0.7	0.3	1.0	180.0	190.0	9.0	0.9	0.4	0.5	0.1	0.02	0.03	0.36	0.7	-1.0	-0.001	-0.1	-1.0				
12	21"-60"	0.1	2.7	1.0	0.3	2.0	30.0	86.0	5.0	0.2	0.3	0.5	0.1	0.02	0.03	0.38	0.7	-1.0	-0.001	-0.1	-1.0				

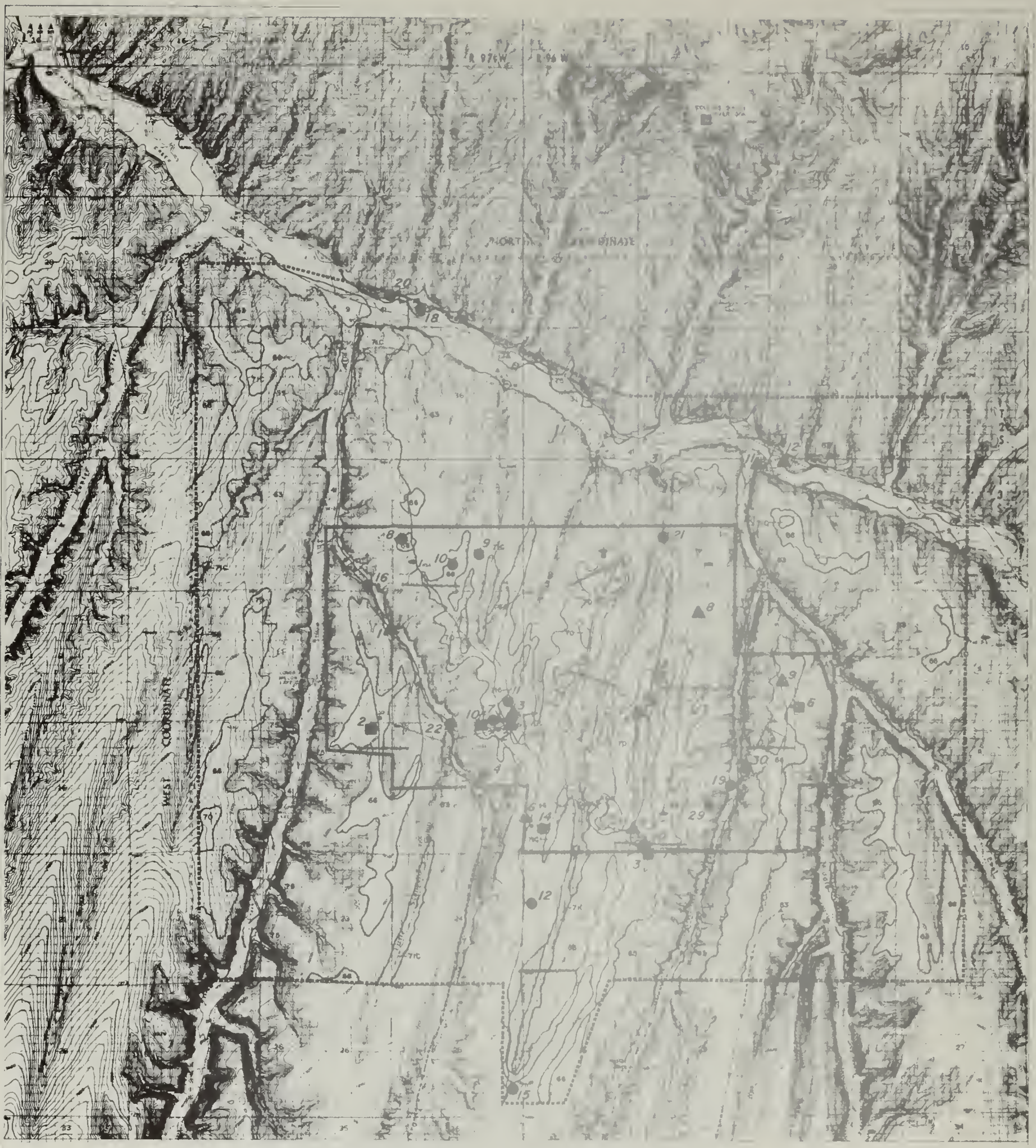
NOTES:

(1) pH-H_2O: 1:2 SOIL WATER RATIO.
(2) CEC: CATION EXCHANGE CAPACITY IN me/100g.
(3) ESP: EXCHANGEABLE SODIUM PERCENTAGE.
(4) Sal & EC: ELECTRICAL CONDUCTIVITY OF SATURATED SOIL PASTE EXTRACT IN mmhos/cm.
(5) SAR: SODIUM ABSORPTION RATIO.
(6) OMN. ESTIMATED NITROGEN AVAILABLE TO PLANTS IN ONE YEAR FROM DECOMPOSITION OF ORGANIC MATTER in ppm.
(7) H_2O Fld Cap.: FIELD MOISTURE CAPACITY AT 1/3 BAR IN PERCENT.
(8) Wilt pt: WILTING POINT OF SOIL AT 15 BAR IN PERCENT
(9) PICOCURIES/g.

MINUS SIGN INDICATES LEVEL IS BELOW REPORTING MINIMUM.

Table II C-16 NUTRIENT ANALYSIS OF SEVEN SOIL SAMPLES FROM TRACT C-b
(Woodward-Clyde Samples)

Nutrients (ppm)	Soil Samples						
	1	2	3	4	5	6	10
NO_3-N	5	27	6	10	7	7	38
NH_4-N	28	39	18	23	38	36	46
p	6	26	16	2	7	24	30
K	120	130	250	300	130	220	490
Ca	4900	2900	2600	3400	4200	2600	4100
Mg	200	380	550	230	290	410	340
SO_4-S	17	6	37	10	27	14	5
Fe	5.2	19	7.2	2.6	9.7	29	6.6
Zn	.5	.4	.5	.2	.5	3.6	1.3
Cu	.7	.3	.8	.5	.5	1.3	.7
Mn	1.0	1.9	3.7	.9	1.4	9.6	2.5
B	.5	.8	.8	.9	.5	.6	1.2
SALTSECx10^3	.28	.47	.27	.31	.32	.29	.58
Water - Holding Capacity, 15 BAR	11	10	14	10	16	18	17



SHALE TRACT C-b
ENVIRONMENTAL AND EXPLORATION ACTIVITIES

LEGEND

9 — HAGGA LOAM
41 — GLENDIVE LOAM
63 — RENTSAC-CHANNERY
66 — REDCREEK-RENTSAC COMPLEX
70 — PICEANCE LOAM
71C — FORELLE LOAM
75 — HANLY LOAM

■ WOODWARD-CLYDE SAMPLING POINT
● C-b SHALE OIL SAMPLING POINT
▲ SCS SAMPLING POINT

[illegible]

SOIL SAMPLE LOCATION MAP

Table II C-17 SOILS OF C-b TRACT - SELECTED SOIL CHARACTERISTICS

MAP SYMBOL	SOIL TYPE OR MAPPING UNIT	SLOPES (PERCENT)	SURFACE LAYER			SUBSOIL OR UNDERLYING LAYER			DEPTH TO BEDROCK (INCHES)	PARENT MATERIAL	PERMEABILITY (LEAST PERMEABLE LAYER)	DRAINAGE	ERODIBILITY HAZARD	DEPTH OF SOIL SUITABLE FOR REVEGETATION (INCHES)
			COLOR (DRY)	TEXTURE	THICKNESS (INCHES)	COLOR (DRY)	TEXTURE	THICKNESS (INCHES)						
9	HAGGA LOAM	0 - 5	LIGHT GRAY	LOAM	25	LIGHT GRAY	CLAY, LOAM	25	>60	ALLUVIUM	MODERATELY SLOW	POORLY DRAINED	SLIGHT	POOR - CLAYEY
41	GLENDIVE FINE SANDY LOAM	2 - 15	PALE BROWN	FINE SANDY LOAM	12	PALE BROWN	LOAMS, LOAMY SAND	27	>60	ALLUVIUM	MODERATE	WELL DRAINED	SLIGHT	GOOD TO 30
63	RENTSAC CHANNERY FINE SANDY LOAM	5 - 50	PALE BROWN	VERY CHANNERY, SANDY LOAM	4	PALE BROWN	VERY CHANNERY SANDY LOAM	7	18	SANDSTONE	RAPID	WELL DRAINED	SLIGHT TO MODERATE	POOR - STONES
66	REDCREEK-RENTSAC COMPLEX	5 - 30	PALE BROWN	SANDY LOAM	6	VERY PALE BROWN	FINE CHANNERY SANDY LOAM	12	19	SANDSTONE	MODERATELY RAPID	WELL DRAINED	SLIGHT	POOR TO 6
70	PICEANCE FINE SANDY LOAM	5 - 15	BROWN	FINE SANDY LOAM	10	LIGHT YELLOWISH BROWN	LOAM	12	37	SANDSTONE	MODERATELY RAPID	WELL DRAINED	SLIGHT TO MODERATE	FAIR TO 10
71C	FORELLE LOAM	3 - 8	BROWN	LOAM	4	PALE BROWN	LOAM	12	>60	AEOLIAN DEPOSIT	MODERATE	WELL DRAINED	SLIGHT	GOOD TO 30
71D	FORELLE LOAM	8 - 15	BROWN	LOAM	4	BROWN	CLAY LOAM	12	>60	AEOLIAN DEPOSIT	MODERATE	WELL DRAINED	SLIGHT	GOOD TO 12
75	HANLY GRAVELLY LOAMY FINE SAND	2 - 9	PALE BROWN	CHANNERY, LOAMY FINE SAND	6	LIGHT YELLOWISH BROWN	SAND	31	>60	ALLUVIUM	RAPID	EXCESSIVELY DRAINED	MEDIUM	POOR TO 6

Bibliography - Section II-C

Calhoun, J. B. and J. U. Casby. 1958. Calculation of home range and density of small mammals. U. S. Public Health Monogr. 55:1-24.

Craighead, J. J. and F. C. Craighead. 1969. Hawks, owls and wildlife. Dover Publications, Inc., New York. 443 pp.

Everhart, W. H. and B. E. May. 1973. Effects of chemical variations in aquatic environments: Vol. I. Biota and Chemistry of Piceance Creek. EPA Ecol. Res. Ser.

May, B. E. 1970. Biota and Chemistry of Piceance Creek. University of Colorado. Unpublished M. S. Thesis.

Pennak, R. W. 1974. Regional Oil Shale Study: Limnological status of streams, summer 1973. Thorne Ecological Institute.

Pettus, D. 1974. Regional Oil Shale Study: Inventory and impact analysis, fishes of the Piceance Basin. Thorne Ecological Institute.

Woodling, J. and C. Kendall, 1974. Investigations of the aquatic ecosystems of Piceance and Yellow creeks, Northwestern Colorado, September and October 1974. Colorado Dept. Public Health, Water Quality Control Division, Denver, Colorado.

II D GEOLOGY

The surface geology report was presented in Quarterly Data Report #5 and in the Annual Summary and Trends Report. Data pertaining to surface geology will be integrated, as it applies to other studies, within Section II E - Ecological Interrelationships.

II E ECOLOGICAL INTERRELATIONSHIPS

II E-1 Introduction

In the Annual Summary and Trends Report a major section was devoted to the "Evolving Conceptualization of Ecological Interrelationships on the C-b Tract." This was the first step in developing a framework for presenting interactions of the various elements of the ecosystem based on the data collected in the environmental baseline program and reported in the previous quarterly data and summary reports.

In this and succeeding quarterly reports a section on Ecological Interrelationships will be added to present major relationships as they are developed through the final year of environmental baseline collection. The final baseline report will present the results of the two-year baseline analysis and focus on the major ecological interrelationships that exist on Tract C-b. The material presented in this section of the remaining quarterly reports will be utilized to construct the Ecological Interrelationship portion of the final report.

The objectives as stated in the Annual Summary and Trends Report were to initiate the conceptualization of such relationships, develop terminology, present basic structure and some conceptual categories from which a more complete understanding of the environment may be obtained. The dynamic nature of this subject will require the evolution of ideas and plans as data and techniques are integrated among and within the various disciplines. Examination of ecological interrelationships requires analysis and synthesis of baseline data, literature review, and the practical experience of the various resource managers and scientists. To define completely the entire ecosystem and all its interrelationships is an enormous task, beyond the scope of this entire project. However, such an approach is invaluable in understanding those key variables and processes most likely to be affected by oil shale development.

II E-2 Discussion of System Variables and Processes

A systems concept requires the development of a logical framework to integrate biotic and abiotic system elements and to identify the data inputs from field, laboratory, and literature within a classification of variables, constants, and processes.

Variables represent the components of the system that can be measured in units. There are defined two types of variables, e.g., those that specify the particular state of the system, state-variables, and those that are external to the system but affect the matter or energy level within the system, driving variables. Processes account for the flows of matter or energy from one state-variable to another and are measured in rates. Some elements of the environment can be measured in either units or in rates, and thus can be classified variables or processes. It is necessary at all times to specify units or rates so as to ascertain if one is speaking of a given element as a variable or process.

The analysis of ecological processes operative on Tract C-b presented in the *Annual Summary and Trends Report* is preliminary. The listing of operative processes (Annual Summary Table VIII-2 and 3) as compared to the measured processes (Annual Summary Table VII-10) indicates some disparity between the two. However, process studies and measurements can be obtained from the literature and from other investigations to close the gap. Attention can be given to the comparison of processes measured in the field versus those for which there is information available in the literature.

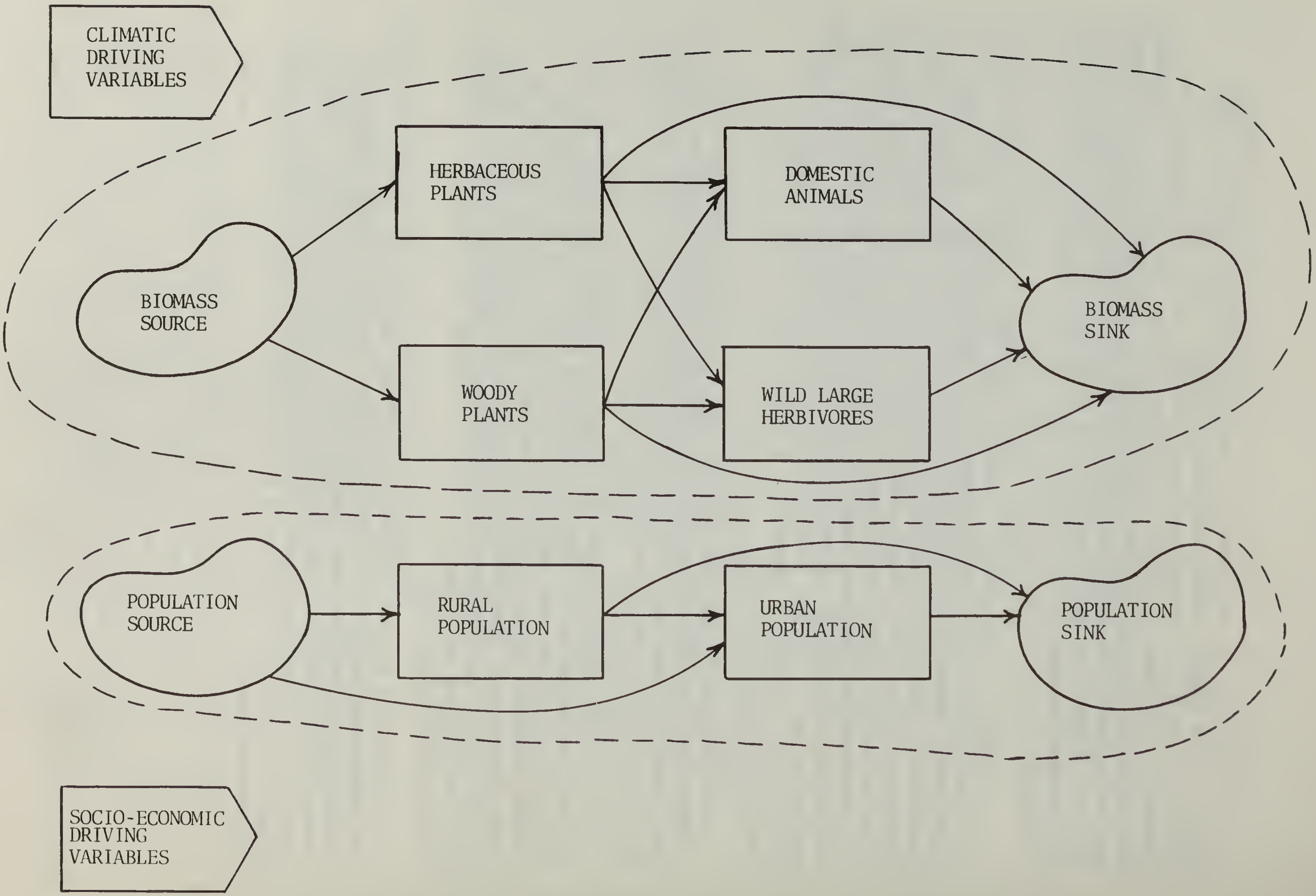
A prototype, diagrammatic structure has been developed and presented as Figure VII-18 in the *Annual Summary and Trends Report*. This conceptual, diagrammatic approach is consistent with the systems approach, and identifies the organism groups according to trophic position and within-trophic categories. Thus, for example, decomposers (such as soil bacteria), producers (vegetation), and consumers (animals) are identified at different levels within the diagrammatic structure. Within each of these categories there may be separate compartments or components. For example, vegetation may be broken into four major plant groups in one community, three groups in another community, a species and a group in another community, and so forth.

One elaboration of this diagram could include additional plant communities, identify by species or group the organism complexes at each level, identify and name the processes accounting for matter and energy flow, and discuss and illustrate the potential effect of these processes.

As an additional example for using this diagram, socio-economic factors can be integrated into this flow as depicted in Figure II E-1. Two parallel systems are defined on this figure-- one depicting the flow of biomass through plants and animals and the other the flow of human population. The boxes in the diagram represent state variables and the kidney-bean shaped objects represent sources and sinks. Note that the driving variables are depicted outside the systems. Which are circled with dashed lines.

Within the system of biomass flow there are two groupings of plants, herbaceous and woody. Biomass flows into these plant compartments by means of photosynthesis and plant growth. The plants either die and decay into the biomass sink or they are utilized by animals, wild or domestic, in processes associated with food selection, digestion, and growth. Eventually the animals are harvested, or they die and enter the biomass sink.

Figure II E-1 A SIMPLIFIED DIAGRAM OF BIOMASS AND HUMAN POPULATION SUBSYSTEMS IN THE C-b TRACT AREA



Human population compartments are simplified to rural and urban populations. There is a population source for births and immigration into the system; there are possible transfers from the rural population to the urban population within the system; and there are flows out of the system by emigration or to a population sink by means of death.

The individual flows can be identified utilizing the following nomenclature:

Symbol Variable

S_b = Biomass source or sink
X_1 = herbaceous plants
X_2 = woody plants
X_3 = domestic animals
X_4 = wild, large herbivores
X_5 = rural population
X_6 = urban population
S_p = population source or sink
Z_1 = climatic driving-variables
Z_2 = socio-economic driving-variables

Each of the flows from a source to a variable or from a variable to a variable is influenced by a number of factors. The sources are identified in Figure II E-2 according to the nomenclature noted in the above listing and the kind of flow is named. Each of the driving variables or state variables affecting that flow process is noted by a check-mark within the body of the matrix in the figure. Note that a variable in the population subsystem can influence a flow rate or process within the biomass subsystem.

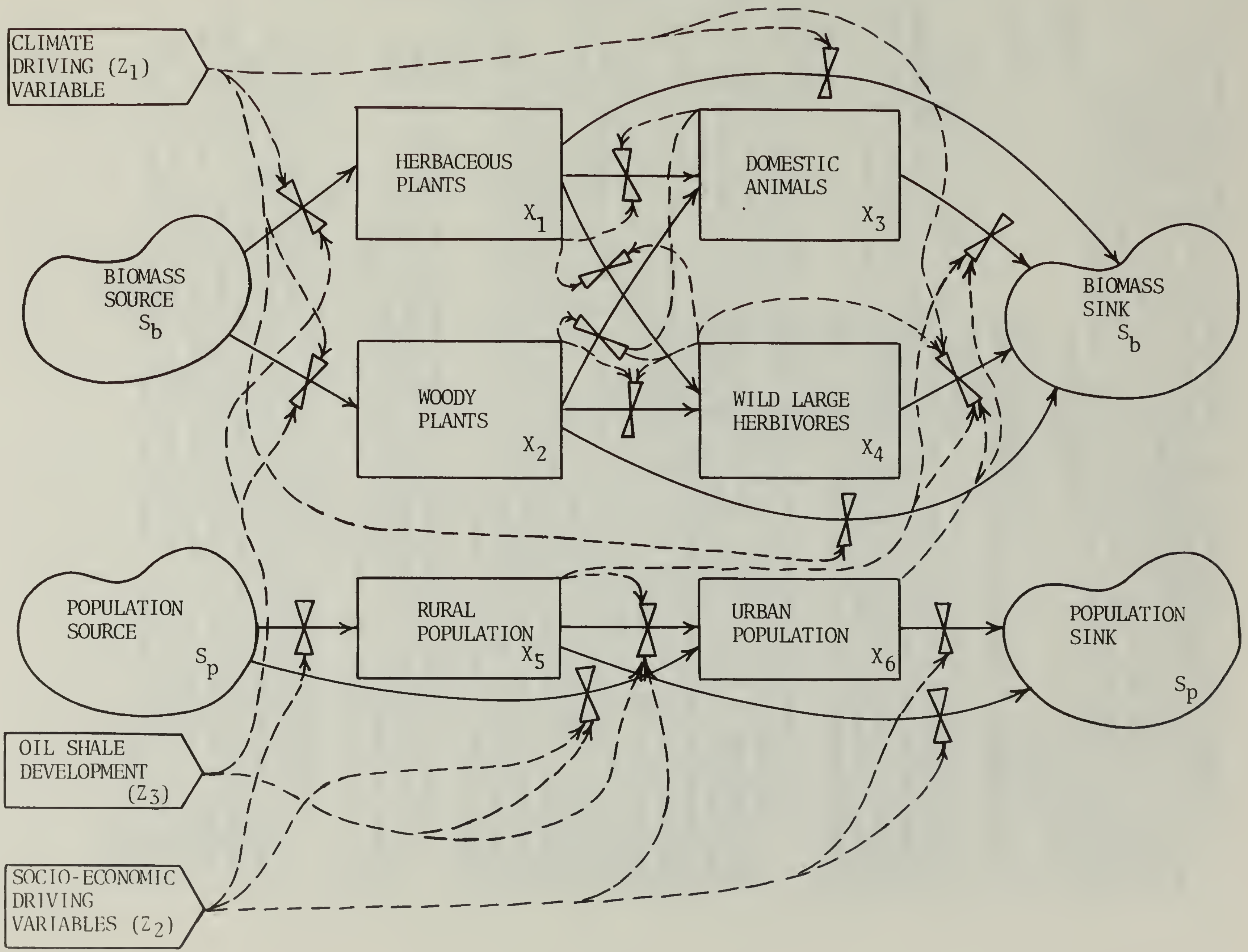
Any particular program, such as that of oil shale development in general, could influence a number of the flows or variables. The effects attributed to the development factors could influence photosynthetic flows, i.e., the flow of biomass from its source (such as atmospheric CO_2) into the plant compartments. Economic development attributed to industrial development could cause considerable immigration into the area's urban component as well as induce migration from rural to urban locations.

In a systems sense it is possible to incorporate the development factors as man-made driving-variables. In Figure II E-3 oil shale development is entered as a third driving-variable, Z_3, and the factors affecting the flows are included. It shows the same sources, sinks, compartments, and driving-variables as does Figure II E-1. Along each flow, depicted as a solid line, is a "valve" with dotted lines and arrows leading to indicate what factors affect that flow. Thus, the variables from the matrix in Figure II E-2 are incorporated in Figure II E-3 with dotted lines.

Figure II E-2 FLOWS IN THE SUBSYSTEMS OF FIGURE II E-1
AND THE FACTORS INFLUENCING EACH FLOW

	FLOW	VARIABLES INFLUENCING FLOWS								KIND OF FLOW
		Z_1	Z_2	X_1	X_2	X_3	X_4	X_5	X_6	
BIOMASS FLOWS	S_b to X_1	✓								PHOTOSYNTHESIS
	S_b to X_2	✓								
	X_1 to S_b	✓								WEATHERING AND DECOMPOSITION
	X_2 to S_b	✓								
	X_1 to X_3			✓		✓				FOOD SELECTION, DIGESTION AND GROWTH
	X_1 to X_4			✓			✓			
	X_2 to X_3				✓	✓				
	X_2 to X_4				✓		✓			
	X_3 to S_b							✓	✓	DEATH AND HARVEST
	X_y to S_b	✓					✓	✓	✓	
POPULATION FLOWS	S_p to X_5		✓							BIRTH
	S_p to X_6		✓							BIRTH AND IMMIGRATION
	X_5 to S_p		✓							DEATH AND EMIGRATION
	X_6 to S_p		✓							
	X_5 to X_6		✓					✓		MIGRATION

Figure II E-3 A DIAGRAM OF BIOMASS AND HUMAN POPULATION SUBSYSTEMS SHOWING FACTORS INFLUENCING EACH FLOW AND SHOWING OIL SHALE DEVELOPMENT AS A DRIVING VARIABLE AFFECTING BOTH SUBSYSTEMS



In summary this diagrammatic and tabular approach allows the development of a large, complex diagram which can encompass many of the features of the C-b Tract area. Such an approach is not limited to the flow of a single variable but could incorporate flows of biomass, population, or dollars. It shows how the states or levels of variables in different subsystems affect the flow rates within the same subsystem or within another subsystem of the overall C-b Tract area.

II E-3 Geology - Soil-Plant Interrelationships

As a part of developing the understanding of system's interrelationships in the Tract C-b study area, the correspondence between soils and vegetation of this area has been previously discussed. This correspondence has been treated both physically and chemically in the analyses. The basis of the relationship between soil and vegetation has been treated extensively in the literature, noteably by Jenny (1941, 1958).

The following discussion further details this interrelationship by including information relating to geologic events that were involved in the formation of certain soil types and the current circumstances that maintain or control soil development. There are several geology-soils relationships which could be discussed. This discussion, however, is centered on three main soil types (Glendive, Piceance, and Forelle loams) that were apparently formed by similar alluvial processes. In more recent times two of these types (Forelle and Piceance loams) have been physically displaced with respect to the source of their parent material by differential stream cutting and so are no longer influenced by alluvial deposition. As a result, two different sets of soils and vegetation relationships have developed: one type (Upland Sagebrush/Forelle and Piceance loams) on ancient stream beds; the other (Bottomland Sagebrush/Glendive loam) on active stream beds.

There is apparent significance in understanding both the past and present controls on soil and vegetation development, especially as they relate to vegetation. This type of understanding can serve as a management tool for assessing impacts to soil-vegetation units.

In comparing the maps of geology, vegetation, and soil for the C-b Tract, some rather striking patterns emerge. This, of course, is not totally unexpected since the relationships between soils and geology and vegetation and soils have been discussed for years. The most dominant similarity in patterns on Tract C-b are those between many of the sediments mapped as colluvial or undifferentiated alluvial-colluvial deposits, the soil series, Forelle Loam, and the vegetation complex designated as the Upland Sagebrush Community. Additional associations are shown in Table II E-1.

Table II E-1 VEGETATION AND SOIL ASSOCIATIONS WITH A GIVEN SURFICIAL DEPOSIT

GEOLOGY	VEGETATION	SOIL
Alluvium	Marsh, Agricultural Area, Riparian Community	Glendive Hagga Loam
Alluvial Fan	Big Sagebrush Greasewood Annual Weed Community	Hanly Loam Hagga Loam
Alluvial-Colluvial Mixed	Big Sagebrush Annual Weed Pinyon-Juniper	Forelle Loam
Colluvium	Big Sagebrush Pinyon-Juniper Mixed-Mtn. Shrub Community Bunchgrass	Forelle Loam Piceance Loam Red Creek - Rentsac Complex

With respect to the various Quaternary deposits, both of the deposits mapped as alluvium (Qal) and alluvial fans (Qf) are topographically situated as one would expect (Figure II E-4). The alluvium is in the valley bottom flanking Piceance Creek; The alluvial fan deposits are deposited at mouths of draws where tributary waters enter onto the floodplain of their master stream. The colluvial deposits (Qc) and the mixed colluvial-alluvial deposits (Qalc) as mapped, are not always where such deposits would be expected to be topographically. A normal position for mixed alluvial-colluvial deposits is in the tributary valley bottoms and adjacent side slopes. Many of these mixed deposits have been mapped in topographic positions that have little relation to present drainage systems. Such deposits are numbered on Figure II E-4.

Similarly, large expanses of colluvial deposits are mapped high enough on the upland that the relationship between source and deposit is difficult to project or is absent altogether. Such deposits, shown as Numbers 1-10, Figure II E-4, suggest that the material may not be colluvially derived but rather the depositional remnants of an ancient drainage system. Deposits that are located in swales in the upland surface lend additional support to this hypothesis (number 3 Figure II E-4).

Instances of alluvium being found on uplands and along ridges are not unique and have been discussed in the literature. Occurrences of sand and gravel capped uplands have been reported in Georgia (Maury, 1902; Eargle, 1955; LeGrand, 1962; Dennis, 1971); in Maryland (Hack, 1955); and in Alabama (Maury, 1902). MacClintock and Richards (1936) observed this phenomenon in the Mid-Atlantic states, calling it reverse topography. Bryan (1940), working in the west, described the process as "gully gravure." These investigators, working in different climato-geomorphic areas, described the process involved in similar terms. Essentially an increase in energy applied to the system, by whatever means, initiates renewed downcutting. The alluvium deposited across the flood plain by the stream and weathered during the previous cycle is more resistant to erosion than the adjacent deposits on the interfluves (topographically high land between stream courses). These interfluvial areas, unprotected by the alluvial capping, become more susceptible to erosion.

Hack (1955), working in Maryland, suggested that the finer materials of the banks and interfluves would erode more easily than the slopes protected by the alluvium. Thus the interfluves would be reduced faster than the stream would be lowered. This process would cause a lateral shift away from these more protected areas. As the drainage system became established the alluvium would gradually achieve an increasingly higher position on the interfluves.

At the low energy, baselevel stage streams would move laterally distributing materials over a wide area. An increase in energy in the system would renew down cutting. Any lateral shifting of the stream during this stage could change the course and leave uneroded alluvial materials on the slopes and eventually on the interfluves. Hack also suggested stream piracy as a process responsible for the establishment

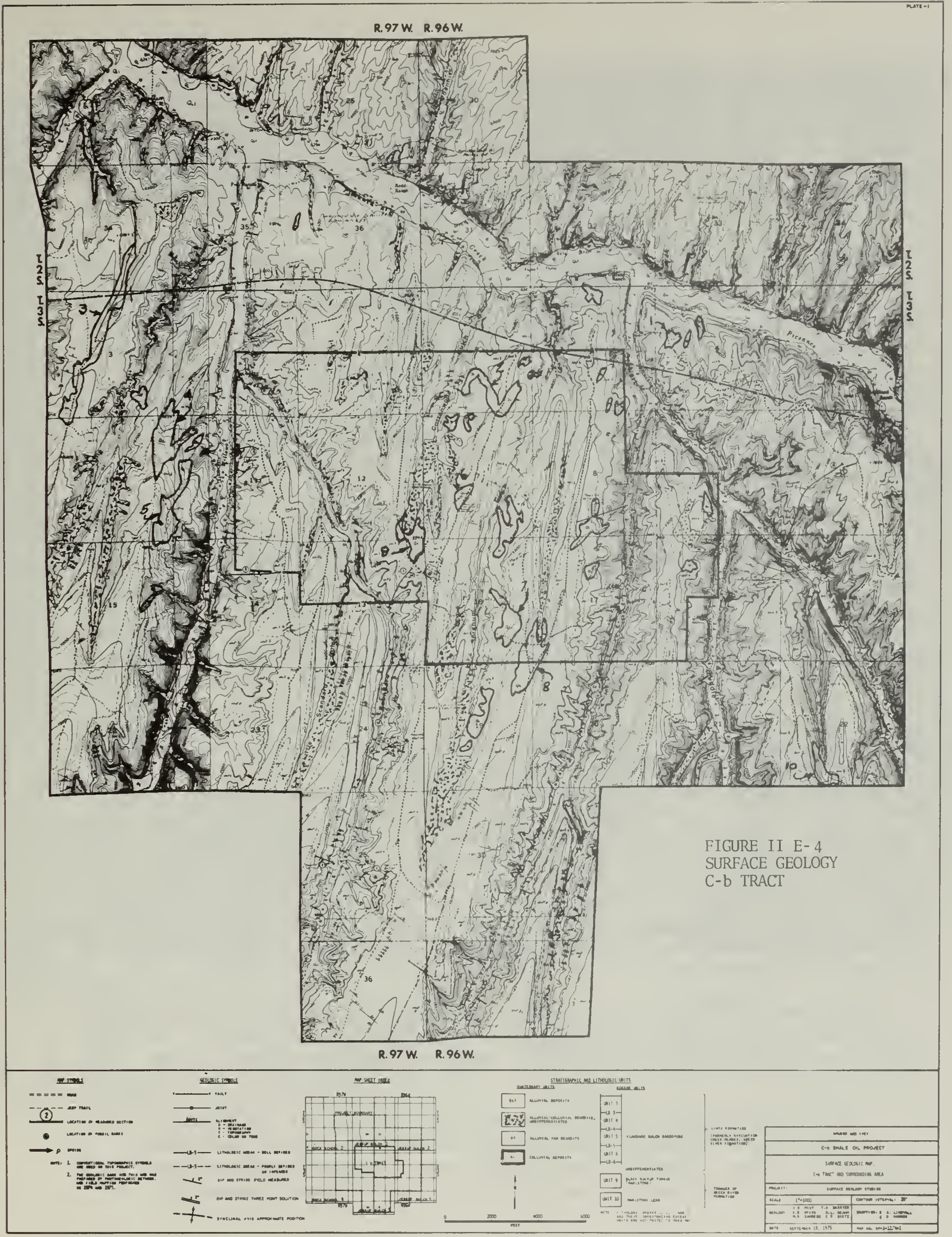


FIGURE II E-4
SURFACE GEOLOGY
C-b TRACT

of alluvial capped slopes and divides. (Stream piracy is the capture of the drainage area of one stream by a more aggressively eroding stream). Major changes in the courses of some streams on Tract C-b may have taken place. It is easy to see how the complete change in the course of a stream and the abandonment of large reaches could account for alluvial deposits in swales on uplands. Of course sufficient time must have passed since abandonment to have caused an inversion of topography.

Unconsolidated materials that have been transported downslope by gravity or slopewash are termed colluvium. Colluvial deposits are usually found on the valley sideslope or at the junction of the valley wall and the floodplain. Rapid movement of surface runoff can actually sweep slopes clear of loose material and deposit it, as a heterogeneous mass, some distance away from the foot slope out into the flood plain. Therefore, care must be taken when classifying floodplain deposits. Difficulties are also encountered when mapping colluvium on the valley side-slope since it is sometimes difficult to distinguish between deposits of material that have developed in situ, i.e. residium, and that same material after it has been transported.

Since the most general topographic location for the accumulation of colluvial deposits is either on the valley sides or at the base of the slope, it is difficult to reconstruct a paleoenvironment such that the many deposits mapped as colluvial could be formed. There are no generalized associations that can be made between all the colluvial deposits and vegetation or soils because of the varying topographic positions of the deposits. However, upland colluvial deposits strongly correlate with the Upland Sagebrush vegetative type and the Forelle loam soil (Figures II E-5 and II E-6).

Alluvial fan deposits are generally ungraded, as are colluvial materials. Dependant primarily on channelized water transportation for their occurrence, alluvial fans are localized and confined to those areas where tributaries empty into their master stream. A decrease in gradient and a reduction of velocity and transporting power at these junctions assist deposition. Velocity loss can be attributed to the lessened gradient as well as seepage into loose, permeable materials. As a result of this seepage, and the nature of the processes forming these deposits, alluvial fans are quite often well-watered and more densely vegetated than deposits on either side. Sub-surface drainage often approaches the surface near the edge of the apron and thus the extent of the fan may be delimited by a change in vegetation.

As shown in Table II E-1 alluvial fan materials support the Big Sagebrush, Greasewood, and annual weed vegetative types. The only two soils mapped on alluvial fans are the Hanly loam and Hagga loam; Hanly loam predominates.

Almost all of the alluvial fans on Piceance Creek in the vicinity of the Tract--and certainly the largest fan deposits--are on the north side of the river. Similarly only Hanly loam is mapped on these fans and furthermore the dominant vegetative type is Greasewood community.

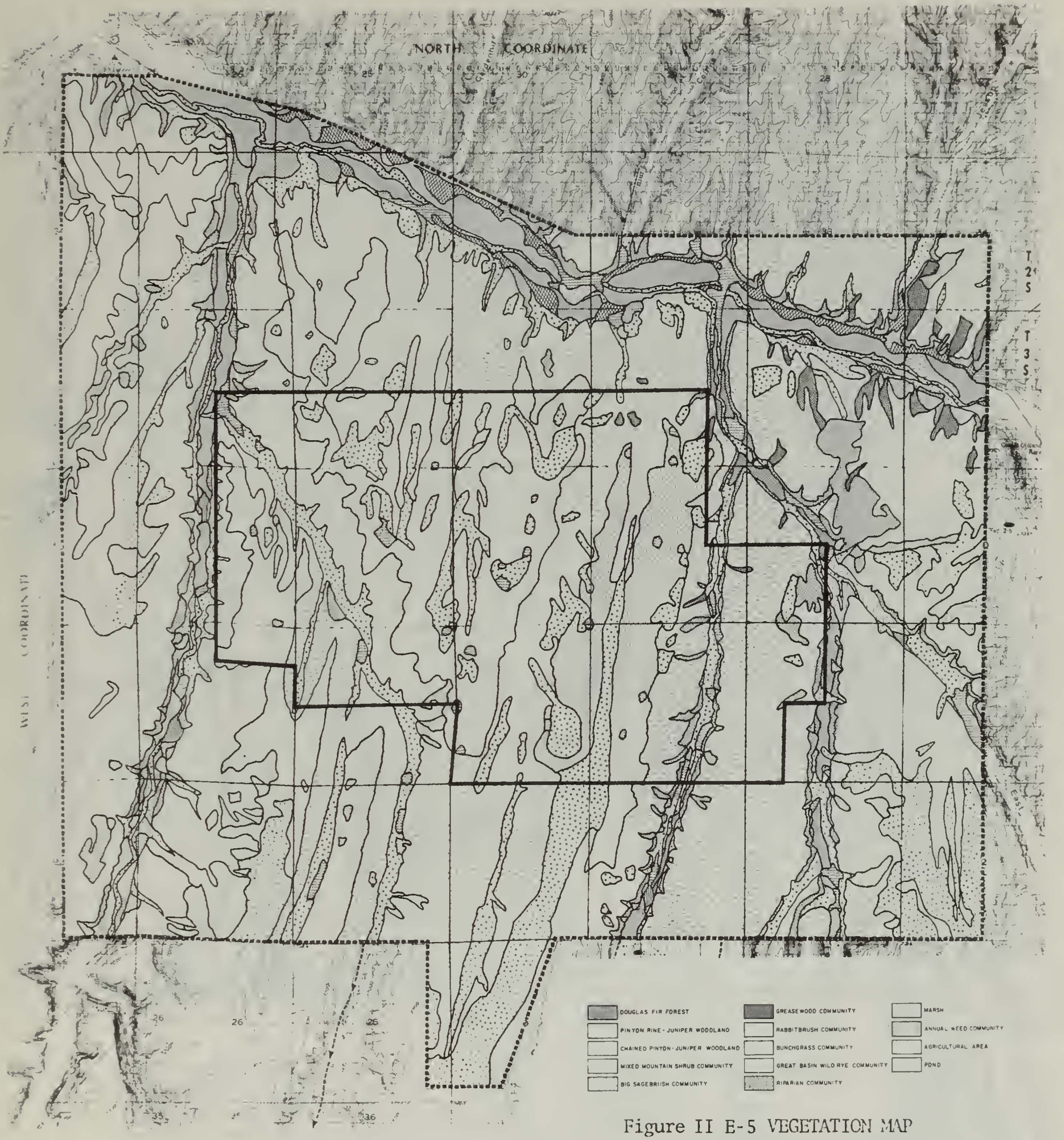


Figure II E-5 VEGETATION MAP

TRACT C-b

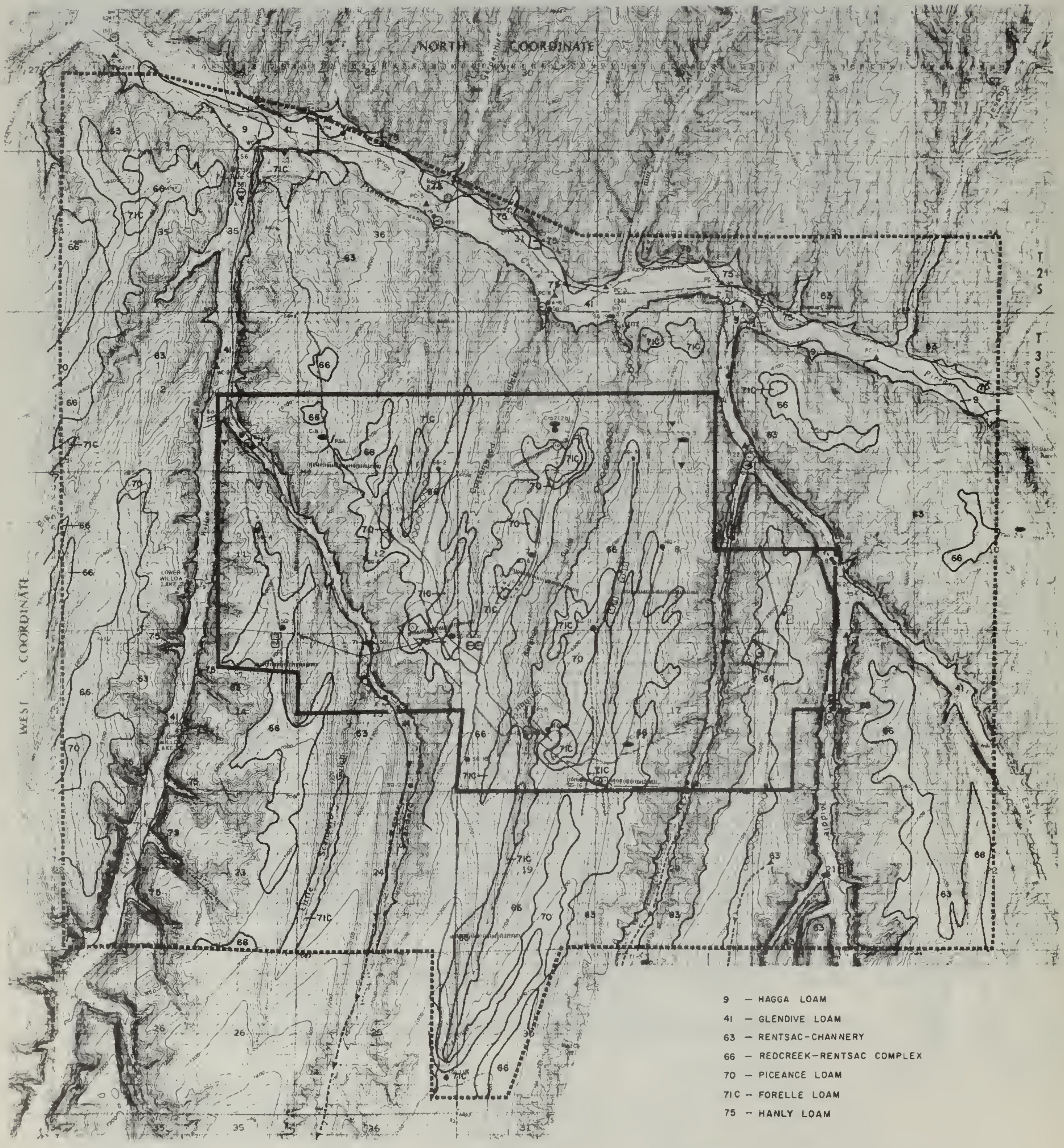


Figure II E-6 SOILS MAP
TRACT C-b

Some alluvial fans are mapped on the south side of Piceance Creek and along the major tributaries. There are no fans mapped at the mouth of Willow Creek or Stewart Gulch. Other than the small fans mapped at the mouth of Sorghum Gulch and Cottonwood Gulch and some minor deposits developed at the mouths of short steep tributaries, there are no fans mapped on the south side of Piceance Creek. Many fans are developed along the tributaries. Many of these deposits might more specifically by described as alluvial cones because of their steeper slopes and more narrow bases.

The geologic mapping unit, Quaternary alluvium, includes all of the genetic types of deposits that would be deposited within fluvial environments. These materials are found in the perennial and ephemeral stream valleys and consist of silt-to-boulder fractions of sandstone, siltstone and marlstone. There is no dominant vegetation type. Because of this general continuity of parent material, topographic position, and moisture content, Glendive loam is the principal soil type mapped on the alluvium. Some small areas of Hagga loam have been mapped on the southside of Piceance Creek.

The principal reason for interest in geologic conditions and geomorphic processes in relation to vegetation is the influence, which the former characteristics exert on the development and maintenance of different vegetation types. In this way, not only can geology and geomorphology reveal information concerning the reason for discontinuities in vegetation types, but they can also relate valuable management-related information as to why (or why not) certain types are naturally maintained.

For example, one could propose (and this is supported by data collected in the Tract C-b study area) that the high salt content, high sulfate regimes, and high pH that exist in Bottomland Sagebrush communities are directly related to the success of Big Sagebrush in these sites, as well as to the exclusion of other types in any abundance. One mechanism, which might be responsible for the chemical characteristics of these sites, is the deposition of salts and sulfate by alluvial processes. These processes not only developed these characteristics originally, as discussed above, but also maintain them. Interruption, acceleration, or any other change which would affect these processes will also exert some effect on the maintenance of the Big Sagebrush stands.

A like origin for Upland Sagebrush stands is also probable. As suggested above, the occurrence of alluvial and colluvial materials on upland sites suggests that these areas might have been influenced by ancient streams. If so, the processes, which were once active in the development and maintenance of these sites, have been truncated; stream downcutting has altered the original course of the streams that deposited materials on these ancient lowlands. The vegetation type - Big Sagebrush - remains, but in an altered state, having a more stunted, sparser appearance than that of the Bottomland Sagebrush stands. The determining factors appear to be chemical. In the absence of continued deposition, the chemical characteristics, which were so critical to the development of a

Bottomland Sagebrush type, are being slowly weathered out. The differences are apparent in the lower stature and density of the big sagebrush plants which occupy upland sites.

The consequences of removal of the upland sagebrush sites do not differ greatly from those affecting the removal of the bottomland type. Secondary effects might be significant, however. The principle effect on Bottomland Sagebrush resulting from upstream dams, diversions, or other modifications of flow would be the alteration of alluvial deposition in these sites. The dynamics of the bottomland big sagebrush communities would be altered by such changes in streams and changes in the vegetation would be expected. This is not the case for upland sites.

The nature of the summary report has dictated the format and hence the brevity of this presentation. In subsequent Summary Reports the relationships presented above will be expanded by development of quantitative data to show more fully the use of these concepts as a management tool related to impacts which might be expected on Tract C-b.

II E-4 Bibliography

Bryan, Kirk. 1940. Gully gravure - a method of slope retreat: Jour. Geomorphology. vol. 3, pp 89-95

Dennis, H. W. 1971. The pre-Recent Sediments and Surfaces of the Georgia Piedmont: unpublished dissertation University of Georgia, Athens, Georgia. 161 pp.

Eargle, D. H. 1955. Stratigraphy of the outcropping Cretaceous rocks of Georgia: U.S. Geological Survey, Bulletin 1014. 101 pp.

Hack, John T. 1955. Geology of the Brandywine area and origin of the upland of southern Maryland: U.S. Geological Survey, Professional Paper 267-a, 41,pp.

Jenny, H. 1941. Factors of soil formation: McGraw Hill, New York. 281 pp.

__________. 1958. Role of the plant factor the pedogenic functions: Ecol. vol. 39, p 5-16.

LeGrand, H. E. 1962. Geology and ground-water resources of the Macon area, Georgia. Georgia Dept. Mines, Mining, and Geology Bulletin 72, 68 pp.

MacClintock, Paul and H. G. Richards. 1936. Correlation of late Pleistocene marine and glacial deposits of New Jersey & New York. Geol. Soc. Amer. Bulletin, Vol. 47. pp 289-338.

Maury, Carlotta Joaquin. 1902. A comparison of the Oligocene of western Europe and the southern United States. Amer. Paleon. Bulletin, Vol. 3, no. 15, pp 1-90.

III

OTHER STUDIES

Of the six studies that have been reported in this section only two are now active -- the Revegetation Program and the Microenvironmental Program. All of the other studies have been submitted as a plan or program of activity or are presently in an inactive status pending the next stage of exploratory work or development.

The completed Fish and Wildlife Management Plan was submitted in the Detailed Development Plan and outlined in Quarterly Data Report #5. The Scenic Values Program was completed and included in Quarterly Data Report #4.

The final report on Cultural and Paleontological Resources for the Archaeological Studies Program has been submitted in Quarterly Data Report #2. All of these programs were summarized in the Annual Summary and Trends Report. The Aerial Photographic Program is inactive.

The possibility exists that additional studies may be necessary in these programs prior to initiation of some development activities. If additional work is required it will be reported. Otherwise, in the future, only active programs will be reported in this section in the Quarterly Data Reports and Quarterly Summary Reports.

In summary:

III A Fish and Wildlife Management Plan

Submitted in Quarterly Data Report #5.

III B Revegetation Program

Active

III C Microenvironmental Program

Active

III D Aerial Photographic Program

Inactive

III E Archaeological Studies

Submitted in Quarterly Data Report #2.

III F Scenic Values Program

Submitted in Quarterly Data Report #4.

III B REVEGETATION PROGRAM

Summaries of revegetation plans for sites disturbed during the exploration phase of Tract C-b activities have been presented in several places. The most recent revision of these plans appears in Quarterly Data and Summary Reports #5. The majority of these sites have been revegetated. Those sites remaining untreated at this time are intended for treatment early this spring, subject to approvals of plans as stated in the last quarterly report.

III C MICROENVIRONMENTAL PROGRAM

The results of data collected from the microenvironmental network during the months of September, October and November are summarized in Tables III C-1 through III C-3. Because of the lag in reducing these data no analyses will be reported on this quarter. Data interpretations will be presented in detail in the 7th Quarterly Report.

Table III C-1

MICROENVIRONMENTAL STATIONS
SEPTEMBER
MONTHLY SUMMARY

STATION NUMBER	SOIL TEMPERATURE °C			AIR TEMPERATURE °C					SOIL MOISTURE %			PRECIPITATION, Total cm*	RELATIVE HUMIDITY, %	WIND SPEED MPH		WIND DIRECTION °Azimuth		NET SOLAR RADIATION, Langleys	VEGETATION TYPE AND LOCATION
	-60 cm	-40 cm	-20 cm	0 cm	1 meter	3 meters	Minimum, Absolute	Maximum, Absolute	-60 cm	-40 cm	-20 cm			1 meter	3 meters	1 meter	3 meters		
1	▨	▨	16.0	▨	▨	▨	-2	35	▨	▨	31	0.08	94	▨	▨	▨	▨	▨	CHAINED PINYON-JUNIPER RANGELAND (Vegetation Plot #1)
2	▨	▨	19.5	▨	▨	▨	-3	39	▨	▨	25	0.20	49	▨	▨	▨	▨	▨	CHAINED PINYON-JUNIPER RANGELAND (Vegetation Plot #2)
3@	28.0	( )	16.0	29.4	27.6	▨	-2	30	40	45	30	1.19	90	5.56	▨	135	▨	▨	UPLAND SAGEBRUSH (Vegetation Plot #3)
4@	16.6	17.4	17.59	15.6	14.2	▨	-5	41	27	28	23	0.36	32	1.98	▨	160	▨	▨	BOTTOM LAND SAGEBRUSH (Vegetation Plot #4)
5	▨	▨	17.0	▨	▨	▨	0	36	▨	▨	21	0.13	76	▨	▨	▨	▨	▨	PINYON-JUNIPER WOODLAND (Vegetation Plot #5)
6@	13.4	13.5	13.7	14.2	10.3	▨	3	36	42	43	39	0.61	43	1.43	▨	161	▨	▨	PINYON-JUNIPER WOODLAND (Vegetation Plot #6)
7@	( )	15.0	14.8	14.2	11.7	( )	-9	45	56	46	28	0.00	41	1.27	( )	204	( )	.63	CHAINED PINYON-JUNIPER RANGELAND (Animal Trapping Grid #1)
8	▨	▨	23.0	▨	▨	▨	0	37	▨	21	21	0.00	33	▨	▨	▨	▨	▨	BUNCHGRASS COMMUNITY (South-Facing Slope)
9	▨	▨	21.0	▨	▨	▨	6	47	20	19	12	0.86	37	▨	▨	▨	▨	▨	BOTTOM LAND SAGEBRUSH (Mouth of Sorghum Gulch)
10	▨	▨	20.0	▨	▨	▨	-4	41	25	26	22	0.43	44	▨	▨	▨	▨	▨	RABBITBRUSH COMMUNITY (Mouth of West Stewart Gulch)
11	▨	▨	17.5	▨	▨	▨	0	37	▨	▨	14	0.00	47	▨	▨	▨	▨	▨	BUNCHGRASS COMMUNITY (West-Facing Talus Slope)
12	▨	▨	18.0	▨	▨	▨	-3	39	25	25	22	0.10	34	▨	▨	▨	▨	▨	BOTTOM LAND SAGEBRUSH (Alluvial Site)
13	▨	▨	15.5	▨	▨	▨	3	35	( )	34	32	0.03	38	▨	▨	▨	▨	▨	MIXED MOUNTAIN SHRUBLAND (North-Facing Slope)
14	▨	▨	16.0	▨	▨	▨	0	35	31	34	30	0.05	75	▨	▨	▨	▨	▨	PINYON-JUNIPER WOODLAND (West-Facing Slope)
15	▨	▨	14.5	▨	▨	▨	0	36	▨	29	25	0.03	50	▨	▨	▨	▨	▨	PINYON-JUNIPER WOODLAND (Cottonwood Gulch)
16	▨	▨	18.0	▨	▨	▨	-1	39	34	32	30	0.00	62	▨	▨	▨	▨	▨	UPLAND SAGEBRUSH (Head of Sorghum Gulch)
17	▨	▨	29.0	▨	▨	▨	( )	( )	( )	( )	( )	0.00	39	▨	▨	▨	▨	▨	ANNUAL WEED COMMUNITY (Abandoned Drill Pad)

@ Continuous Recording Stations
* Precipitation Values Are Totals For Period, Minimum And Maximum Temperature Values Are Absolute; All Other Values Are Expressed As Means
▨ Values Not Measured At These Stations
() Values Not Available For This Period Due To Instrument Failure

Table III C-2

MICROENVIRONMENTAL STATIONS
OCTOBER
MONTHLY SUMMARY

STATION NUMBER	SOIL TEMPERATURE °C			AIR TEMPERATURE °C					SOIL MOISTURE %			PRECIPITATION, Total cm*	RELATIVE HUMIDITY, %	WIND SPEED MPH		WIND DIRECTION °Azimuth		NET SOLAR RADIATION, Langleys	VEGETATION TYPE AND LOCATION
	-60 cm	-40 cm	-20 cm	0 cm	1 meter	3 meters	Minimum, Absolute	Maximum, Absolute	-60 cm	-40 cm	-20 cm			1 meter	3 meters	1 meter	3 meters		
1	▨	▨	( )	▨	▨	▨	2	30	▨	▨	31	0.43	85	▨	▨	▨	▨	▨	CHAINED PINYON-JUNIPER RANGELAND (Vegetation Plot #1)
2	▨	▨	( )	▨	▨	▨	9	31	▨	▨	25	0.41	63	▨	▨	▨	▨	▨	CHAINED PINYON-JUNIPER RANGELAND (Vegetation Plot #2)
3@	22.1	( )	20.9	19.9	20.6	▨	0	8	38	42	40	0.46	92	5.09	▨	142	▨	▨	UPLAND SAGEBRUSH (Vegetation Plot #3)
4@	( )	( )	( )	( )	( )	▨	11	33	28	28	27	0.50	77	( )	▨	( )	▨	▨	BOTTOM LAND SAGEBRUSH (Vegetation Plot #4)
5	▨	▨	( )	▨	▨	▨	1	32	▨	▨	22	0.10	91	▨	▨	▨	▨	▨	PINYON-JUNIPER WOODLAND (Vegetation Plot #5)
6@	10.4	9.8	9.2	9.7	7.8	▨	1	27	38	38	34	0.48	59	1.25	▨	174	▨	▨	PINYON-JUNIPER WOODLAND (Vegetation Plot #6)
7@	( )	11.0	9.4	8.2	8.1	( )	-7	30	53	46	25	( )	51	2.02	( )	189	( )	.53	CHAINED PINYON-JUNIPER RANGELAND (Animal Trapping Grid #1)
8	▨	▨	( )	▨	▨	▨	5	38	▨	19	13	0.00	51	▨	▨	▨	▨	▨	BUNCHGRASS COMMUNITY (South-Facing Slope)
9	▨	▨	( )	▨	▨	▨	-10	30	21	21	18	0.43	77	▨	▨	▨	▨	▨	BOTTOM LAND SAGEBRUSH (Mouth of Sorghum Gulch)
10	▨	▨	( )	▨	▨	▨	12	32	25	24	21	0.43	82	▨	▨	▨	▨	▨	RABBITBRUSH COMMUNITY (Mouth of West Stewart Gulch)
11	▨	▨	( )	▨	▨	▨	8	32	▨	▨	14	0.00	69	▨	▨	▨	▨	▨	BUNCHGRASS COMMUNITY (West-Facing Talus Slope)
12	▨	▨	( )	▨	▨	▨	12	33	26	25	22	0.48	81	▨	▨	▨	▨	▨	BOTTOM LAND SAGEBRUSH (Alluvial Site)
13	▨	▨	( )	▨	▨	▨	10	30	35	33	31	0.66	62	▨	▨	▨	▨	▨	MIXED MOUNTAIN SHRUBLAND (North-Facing Slope)
14	▨	▨	( )	▨	▨	▨	-7	38	30	33	26	0.13	63	▨	▨	▨	▨	▨	PINYON-JUNIPER WOODLAND (West-Facing Slope)
15	▨	▨	( )	▨	▨	▨	-9	30	▨	29	26	0.20	64	▨	▨	▨	▨	▨	PINYON-JUNIPER WOODLAND (Cottonwood Gulch)
16	▨	▨	( )	▨	▨	▨	8	29	31	31	29	0.46	88	▨	▨	▨	▨	▨	UPLAND SAGEBRUSH (Head of Sorghum Gulch)
17	▨	▨	( )	▨	▨	▨	10	29	( )	( )	( )	0.00	94	▨	▨	▨	▨	▨	ANNUAL WEED COMMUNITY (Abandoned Drill Pad)

@ Continuous Recording Stations
* Precipitation Values Are Totals For Period, Minimum And Maximum Temperature Values Are Absolute; All Other Values Are Expressed As Means
▨ Values Not Measured At These Stations
() Values Not Available For This Period Due To Instrument Failure

Table III C-3

MICROENVIRONMENTAL STATIONS

NOVEMBER
MONTHLY SUMMARY

STATION NUMBER	SOIL TEMPERATURE °C			AIR TEMPERATURE °C					SOIL MOISTURE %			PRECIPITATION, Total cm*	RELATIVE HUMIDITY, %	WIND SPEED MPH		WIND DIRECTION °Azimuth		NET SOLAR RADIATION, Langleys	VEGETATION TYPE AND LOCATION
	-60 cm	-40 cm	-20 cm	0 cm	1 meter	3 meters	Minimum, Absolute	Maximum, Absolute	-60 cm	-40 cm	-20 cm			1 meter	3 meters	1 meter	3 meters		
1	▨	▨	2.0	▨	▨	▨	-12	25	▨	▨	39	0.76	24	▨	▨	▨	▨	▨	CHAINED PINYON-JUNIPER RANGELAND (Vegetation Plot #1)
2	▨	▨	6.5	▨	▨	▨	-9	26	▨	▨	42	1.42	21	▨	▨	▨	▨	▨	CHAINED PINYON-JUNIPER RANGELAND (Vegetation Plot #2)
3@	( )	( )	1.0	( )	( )	▨	-19	18	45	42	37	1.27	37	5.48	▨	141	▨	▨	UPLAND SAGEBRUSH (Vegetation Plot #3)
4@	6.4	4.7	3.2	0.9	0.5	▨	-10	28	27	30	44	1.14	36	1.84	▨	157	▨	▨	BOTTOM LAND SAGEBRUSH (Vegetation Plot #4)
5	▨	▨	5.0	▨	▨	▨	-13	22	▨	▨	27	2.49	23	▨	▨	▨	▨	▨	PINYON-JUNIPER WOODLAND (Vegetation Plot #5)
6@	6.2	4.7	3.6	2.9	2.4	▨	-11	22	39	45	45	3.07	20	1.19	▨	167	▨	▨	PINYON-JUNIPER WOODLAND (Vegetation Plot #6)
7@	( )	3.4	4.6	-1.9	-4.5	( )	-13	25	46	46	45	( )	19	3.35	( )	212	( )	.35	CHAINED PINYON-JUNIPER RANGELAND (Animal Trapping Grid #1)
8	▨	▨	12.0	▨	▨	▨	-4	31	▨	20	18	0.00	20	▨	▨	▨	▨	▨	BUNCHGRASS COMMUNITY (South-Facing Slope)
9	▨	▨	4.5	▨	▨	▨	-16	29	19	21	32	0.97	26	▨	▨	▨	▨	▨	BOTTOM LAND SAGEBRUSH (Mouth of Sorghum Gulch)
10	▨	▨	2.3	▨	▨	▨	-10	24	26	25	35	1.32	37	▨	▨	▨	▨	▨	RABBITBRUSH COMMUNITY (Mouth of West Stewart Gulch)
11	▨	▨	2.3	▨	▨	▨	-17	26	▨	▨	33	0.00	20	▨	▨	▨	▨	▨	BUNCHGRASS COMMUNITY (West-Facing Talus Slope)
12	▨	▨	2.8	▨	▨	▨	-19	29	26	25	45	1.57	19	▨	▨	▨	▨	▨	BOTTOM LAND SAGEBRUSH (Alluvial Site)
13	▨	▨	0.3	▨	▨	▨	-15	23	( )	35	46	1.50	22	▨	▨	▨	▨	▨	MIXED MOUNTAIN SHRUBLAND (North-Facing Slope)
14	▨	▨	1.3	▨	▨	▨	-14	26	31	32	46	2.92	25	▨	▨	▨	▨	▨	PINYON-JUNIPER WOODLAND (West-Facing Slope)
15	▨	▨	0.0	▨	▨	▨	-9	51	▨	33	43	0.90	23	▨	▨	▨	▨	▨	PINYON-JUNIPER WOODLAND (Cottonwood Gulch)
16	▨	▨	2.0	▨	▨	▨	-10	24	31	29	46	1.32	24	▨	▨	▨	▨	▨	UPLAND SAGEBRUSH (Head of Sorghum Gulch)
17	▨	▨	6.3	▨	▨	▨	-21	41	( )	( )	( )	0.00	23	▨	▨	▨	▨	▨	ANNUAL WEED COMMUNITY (Abandoned Drill Pad)

@ Continuous Recording Stations
* Precipitation Values Are Totals For Period, Minimum And Maximum Temperature Values Are Absolute; All Other Values Are Expressed As Means
▨ Values Not Measured At These Stations
() Values Not Available For This Period Due To Instrument Failure

Form 1279–3
(June 1984)

BORROWER'

TN 859 .C64 C37
C-b Shale Oil Pr
Tract C-b: summa

DATE LOANED	BORROWER

USDI – BLM